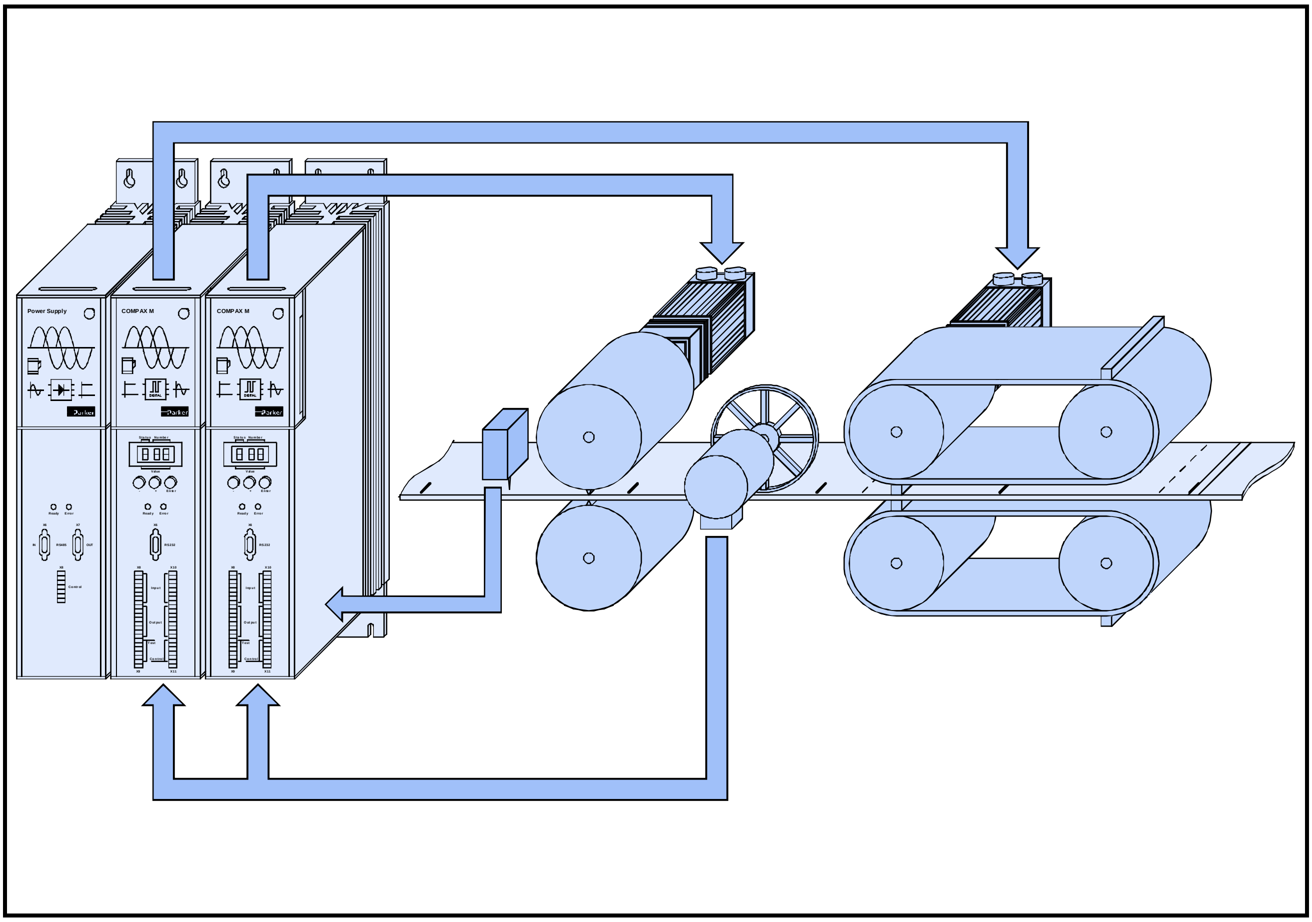
Operating Instructions

Cam controller

-Supplement to COMPAX Standard-Documentation-



From software version V3.61

November 98

HAUSER
We automate motion

DIN EN ISO 9001
CERTIFIED QUALITY SYSTEM
Reg. Nr. 36 38 - 01

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Parker

1 Contents

This documentation applies for these devices:

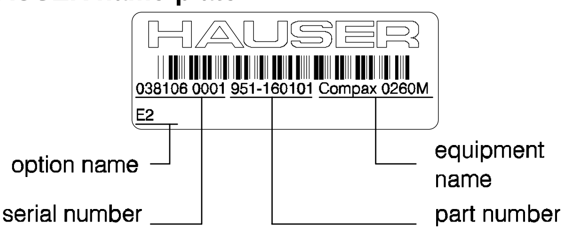
COMPAX 2570S
COMPAX 4570S
COMPAX 8570S
COMPAX P170M
COMPAX 0270M
COMPAX 0570M
COMPAX 1570M
COMPAX 3570M

Key for device designation

COMPAX 0260M:

COMPAX: Name
02: Rated power
60: Variant e. g. "00": standard device
M: Type of device M: multi-axis device

HAUSER name-plate



This documentation is a supplement to the User Guide:

Note, **if the program is not functioning:**
The output stage is disabled in the basic condition! **It can be enabled by I12="1".**

Prior knowledge

All operations using the cam controller assume that the user already understands the standard functions given in the COMPAX User Guide.

State of delivery

With curve 1 COMPAX contains a straight line with gradient 1. The remaining curve parameters are 0.

New functions from software V3.61:

Function "Curves linked" for dynamic curve switching.

2 Overview

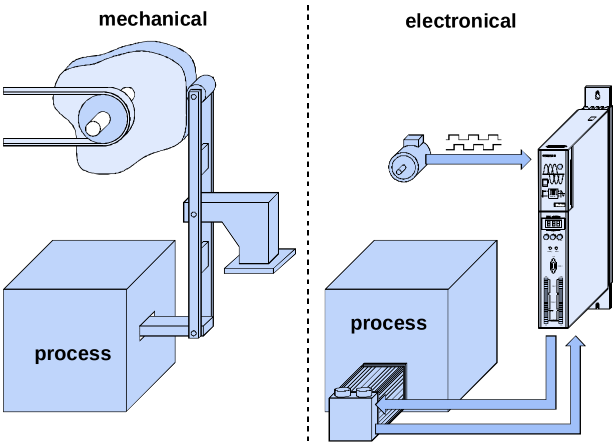
The cam controller differs from the COMPAX standard device with the following characteristics:

Required Options:	-
Absolute value sensor:	The option "Absolute value sensor", as in the standard device, serves exclusively to determine the actual position after "Power on".
Possible Operation Modes:	Same as standard device, but supplemented by the "Reset Mode"
Applicable drive types:	Same as standard device, but supplemented by the drive type "Roller Feed".
Mechanical Reference System:	Same as standard device, but supplemented by the units "Increments" and "Degree".
Additional Commands:	SETC n: Curve selection SETM x: Choosing of master start point SETS: Adjustment of curve starting point POSR CAM: Travelling to curve point LOOP m: Activating of cam operation
Locked Commands:	◆ **Label related positioning;** ◆ **GOSUB EXT** ◆ **OUTPUT O0** ◆ **SPEED SYNC;** ◆ **GOTO EXT;** ◆ **Fast start** via **I15.**
New Functions:	Positioning according to a specific motion profile. Online label synchronization
modified I/O functions:	I12: Enable output stage I13: ="0": decoupling ="1": coupling I14: Label input I15: ="0": Disable auxiliary functions ; ="1": Enable auxiliary functions I16: Enable master position counting O13/O14: Not available by means of "OUTPUT"-command O14: Label error O15: Max. acceptable tracking warning O16: Synchronous operation
Modified Parameters:	P30: Select master input P31: Operation mode of I16 P32: Distance of label sensor P33: Operation mode of label synchronization P34: Coupling mode P35: Scaling factor for master P36: Scaling factor for slave P37: Reset value for digital auxiliary functions P38: Mask for digital auxiliary functions P39: Ramp time of internal time base P79: Max. acceptable tracking warning P80: Drive type supplemented by the "Roller Feed" P90: Units supplemented by "Increments" and "Degree" P93: Operation mode supplemented by "Reset Mode" P98: Distance per master encoder revolution P144: Operation mode of master input channel P210: Activation of parallel set operation
Modified Status:	S2: In cam operation: Variable of last LOOP command; otherwise: Set point S41: Master rotation speed in min^{-1} S42: Master position in increments S43: Number of the activated curve S44: Master position in ‰ of the master cycle S45: Internal slave set point of the curve in ‰ of the slave cycle. S46: Sign of master rotational speed S47: Slave set point from interpolation in units S48: Loop counter of the LOOP-m-command (counts downward from m to 0). S49: Physical target position for POSR S50: Internal label reference in ‰ of the corresponding cycle S51: Label value in ‰ of the corresponding cycle. S52: Label correction in ‰ of the corresponding cycle.
Miscellaneous:	E17: Error message when selecting non-existent curve

3 General description

Due to the growing rationalization and an increasing automation concerning technical processes, plant manufacturing nowadays requires modern and flexible drive conceptions. By introducing digital and communicable controller devices there was made an important step towards the decentralization of control tasks. It thus has been possible to replace an increasing number of mechanical construction elements by programmable servo drives. Especially mechanical cams have been used in many domains of engineering until today. Beside complex motion profiles mechanical cams offer a high tracking accuracy as well as a stiff coupling of master - and slave-drives. There are, however, a few disadvantages such as the long time needed for modification and the limitation to a determined profile.
With the electronical cam controller COMPAX XX70 this loss of time can enormously be reduced especially when switching over between small lots. Construction volume, costs and maintenance can substantially be diminished by the decentralization of the drive power.
Within COMPAX there are implemented in one single axis-module all control functions, which offer a flexible and cost efficient solution of complex motion profiles and synchronizing processes. Switching over from one motion profile to another can be done by a special command within seconds.
Big drive systems which are coupled mechanically can be split up to small individual drive units. The dynamic and stationary characteristics of each drive unit can now be individually adjusted and optimized.

Range of Application

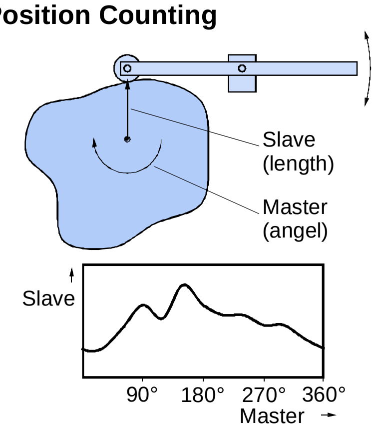


With COMPAX XX70 mechanical cams and cam controllers can be imitated electronically.
Discontinuous material feed, cutting on the fly and similar drive applications with splitted drive power would be possible.
The compact servo drive counts the impulses of the incremental encoder of a master axis and controls, by means of a certain motion profile, which is defined as a set point memory, either a synchronous or an induction servo motor. The combination of controlling unit and power output stage in one device offers numerous advantages such as:

- quick and simple starting-up.
- fast and stable control ex-factory.
- diminished need of peak torques as well as a high tracking accuracy due to feed forward measures.
- only two decoupled optimizing parameters (stiffness and damping) for three control loops.
- digital control from the set point generator to the power output stage.
- lower need of wiring and thus enormously reduced susceptibility to trouble.

Controlling Functions

Master Position Counting



Depending on the angle of the leading axis (master) the follow axis (slave) will travel according to a motion profile defined by the user. The master position is indicated by encoder signals. It moves cyclically within the master cycle. Each cycle corresponds to one cam rotation. By means of the master position there is indicated a sequence of up to 2500 set points between which COMPAX is interpolating in a linear manner. Out of these position set points there are formed the feed forward signals for the subordinate controller cascades of the slave axis. This feed forward of speed and acceleration serves to largely reduce the tracking error of the slave axis.
The counting of the master position can be enabled or disabled by means of a control input.

Cam controller

Each set point can be given a digital and analogue auxiliary function. By means of an enabling mask there can be controlled up to 8 digital outputs at an activation time of max. 3 ms. Additionally there can be put out 2 analogue signals within +/- 10V.

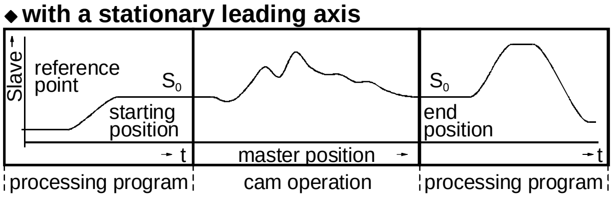
Cam memory

Set points and auxiliary functions are stored in COMPAX in a Zero-Power-Ram protected against mains failure. The writing of the memory is done by Standard-RS232-interface RS485 interface or by InterBus S. The cam memory is able to store several curves simultaneously.

Synchronization on the Fly

An essential function for complex plant manufacturing is the synchronization on the fly of single drives, actuated by an external control signal. When coupling, the slave is synchronized to the curve by a determined travel profile, without any discontinuity in speed. When decoupling the slave leaves the synchronous motion and is stopped at a defined point. Coupling and decoupling can be done in different ways:

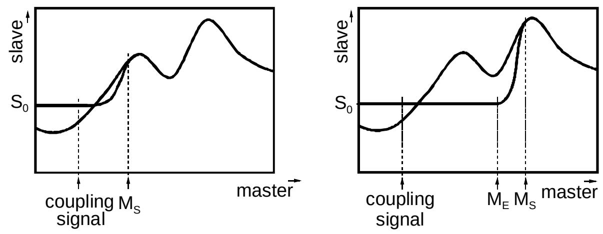
- **with a stationary leading axis**



In the most simple case the slave axis is initialized after "Power-on" by a reference drive. After the external start COMPAX selects the desired curve and is now ready to follow the master axis. Normally the master axis now starts its motion. The slave axis immediately travels according to the indicated curve profile.

- **with an active leading axis**

On the occurrence of the external control signal "Coupling" the slave axis starts its movement in order to reach the curve at the synchronous position "M_S" (see below). The control signal must be given in time so that the axis can carry out its coupling movement without any tracking error. It would be suggestive to obtain a defined coupling profile by choosing the operation mode "Wait for Coupling Position". Thus the slave axis only starts after the master axis has reached the coupling position M_E. When disabling the control signal "Coupling", decoupling is done in an analogous manner. According to a defined profile the slave decelerates by braking at the decoupling position M_A. It reaches brake position M_B and thus stops at stand-still position S_0.



Feed forward

An essential method to avoid tracking errors is the calculation of feed forward signals for the complete cascade structure. The position set points taken from the curve are differentiated and then switched on the subordinate control loops as rotational speed, acceleration - and voltage feed forward.

Synchronous operation, Tracking warning

After synchronization on the fly, the slave now moves synchronously to the set curve. This is indicated by giving the output "Synchronous Operation". Eventual deviations between actual value and set curve exceeding the value "max. acceptable tracking warning" would be monitored by a digital output. The production speed could consequently be optimized i.e. it could be adapted to the max. capacity of the drive.
Apart from the synchronous operation COMPAX can be operated like a position controller. The cam operation may thus be involved in any procedural program.

Label synchronization

In the packaging and printing industry a synchronization of slave axis to print labels is often necessary in order to compensate for material slip. If the master position i.e. the slave position counted in the slave is corrected by the slip, calculated between product and label sensor, the error can be compensated until the next label appears.

Cam editor

Before storing a curve in COMPAX there must be worked out a table containing the set points and the corresponding auxiliary functions. This curve delineation is supported by a PC program, which supports a numerical input of set points, auxiliary functions and coupling positions. The cam editor as well as further auxiliary programs are contained in a Windows-surface which allows the user to quickly commence his work with COMPAX.

4 Configuration

Before configuring COMPAX the drive has to be disabled.
Please observe the operating instructions of the standard device!
The configuration described in the standard operating instructions has to be extended as follows:

4.1 Operation modes

In addition to "Normal mode" (P93="1"), "Endless mode" (P93="2"), and "Speed control mode" (P93="4"), the operating mode "Reset mode" is available for the cam controller on P93="3".

Operation mode	**P93**	**P93="3": Reset mode** This operating mode is only applicable for open curves (Curve start ≠ Curve end, see page 16) aus. **Recommended:** Please use this operation mode for the curve operation!

The reset mode is only active during cam operation. At the end of the curve the actual position is reset to the beginning of the curve i. e. the actual value of the slave does not increase at open curves. The indicated actual slave value is moving between curve start and curve end during the whole cam operation. With the 2nd curve travel the absolute reference to the zero point ceases to exist. (This only refers to open curves).

Out of curve travel: this operation mode corresponds to the standard operation.

Application: With open curves that are travelled cyclically The "Reset mode" prevents range limits (software end limits P11, P12) from being exceeded.

The operation mode "Reset mode" is a default setting.

4.2 Units

4.2.1 Unit for distances:

The units "Millimeter" (P90="1") and "Inch" (P90="2") are supplemented by the units "Increments" and "Degree".

Unit of distance	**P90**	P90="0": "Increments" (see below) P90="3": " Degree" In the drive type "Universal drive", P83 must be given in millidegree ($\frac{1}{1000}$ degree).

4.2.2 Unit "Increments"

By the measuring unit "Increments" it will be possible to guarantee a synchronous operation without drift and calculation errors.

This measuring unit is only efficient when using the drive type "Universal drive"; the accuracy of other drive types cannot be increased.

Using the measurement unit "Increments", the "distance per motor revolution" (P83) is defined in increments when configuring the "Universal drive". This value also specifies the resolution.

For accuracy, P83 must be specified as a 2^n number.
Where: P83 = 2^n with n = 4, 5, 6, ...16
This corresponds to a resolution of 16 ... 65536 increments per motor revolution.
Example: At 32 increments per revolution (P83 = 32), COMPAX implements a positioning process in POSR 64 that corresponds to 2 motor revolutions.
P83 influences the resolution and also the max. travel distance:
The max. travel distance is limited to ±4 million units. This corresponds to 61 revolutions at a maximum resolution of 65536 increments per motor revolution. The maximum travel distance can be increased by reducing P83. The following applies:

P83	max. travel per motor revolution	P83	max. travel per motor revolution
16	250000	2048	1953
32	125000	4096	976
64	62500	8192	488
128	31250	16384	244
256	15625	32768	122
512	7812	65536	61
1024	3906		

In **endless mode**, this restriction applies to a single command or curve.
In **normal mode** and in the **reset mode**, this restriction applies to the whole travel area.

4.2.3 Unit "Degree"

Unit in angular degree (P90="3") for rotary motions (one revolution = 360°).
In "Universal drive", P83 must be given in millidegree ($\frac{1}{1000}$ degree).

4.3 Drive type "Roller feed"

Within the electronical cam control it is possible to use the drive type "Roller feed". This type is to be configured as follows:

Select drive type	**P80**	**P80="32": roller feed**
configu-ration of roller feed	**P82** **P83** **P84** **P85** **P88**	**Roller feed** **P82: Moment of inertia of the feed rollers** moment of inertia of both feed rollers. Range: 0...7000kgcm^2 **P83: Circumference of feedrollers** Range: 30...3000mm **P84: Moment of inertia of the gear** moment of inertia gear and coupler related to the motor shaft. Range: 0...200kgcm^2 **P85: Gear ratio** Range: 1 (1:1)...100 (100:1) ≡ motor: gear **Restriction:** $\frac{P83}{P85} \le 300mm$ **P88: Translational moved mass** Max. translational moved mass (between the next clamping points) Range: 0...500kg

For the configuration of **motor type, ramp profile** and **direction** please use the standard documentation COMPAX.

4.4 Software end limit supervision

With COMPAX 70 the motions towards limits can also be supervised during cam operation. The parameters P11 and P12 serve as limits. (P11 = positive limit, P12 = negative limit).

Function:

The slave follows the master; when reaching the limits,

- the slave will be stopped,
- the cam operation will be interrupted,
- the counting impulses at the encoder input will be disabled
- there will be given the error report "E25: position invalid".

- **Quitting of error report:**
- after "Quit" ,COMPAX 70 is ready for an internal positioning; nevertheless the encoder input is still disabled.
- **Enabling of the encoder input:**
- master position measurement must again be switched on (see page 23).

After the encoder input has been enabled the slave also moves beyond the software limits. The limit supervision only becomes active again when the slave moves back to the admissible area.

Switching off the software limit supervision

please put the limits onto the preset values:

- P11=+4 000 000
- P12=-4 000 000
- The permissible value areas of the limits are:
- P11: 1...4 000 000
- P12: -1...-4 000 000

> **Attention!**
> When limit supervision is activated in normal mode after "Power on", normal operation is only initiated once the machine datum has been reached.
> This also applies for the time between the activation of the machine datum travel until the machine datum is reached.

Advice

For endless axes, use P93=3". In this case, software end limit supervision is ineffective as the datum is never reached due to the reset function.

4.5 Master reference system

4.5.1 P98: Distance of the master axis per encoder revolution

P98 is input using the same units as the master cycle.
Range: 0 ... 4 000 000; Default value: 360
valid with VC.

Determination of P98 when the master axis is driven by a COMPAX.

Assumption: The master movement is sensed by an encoder simulation in Master-COMPAX or an encoder fitted on the master motor.

Master	Slave
P80=2 (Spindle) P83: Spindle gradient P85: Gears	$P98_S = \frac{P83_M}{P85_M}$ [mm]
P80=4/8 (Rack and pinion/timing belt) P82: Tooth number P83: Tooth pitch P85: Gear ratio	$P98_S = \frac{P82_M \bullet P83_M}{P85_M}$ [mm]
P80=16 (Universal drive) P83: Distance per motor revolution	$P98_S = \frac{P83_M}{1000}$ [mm]
P80=32 (Roller feed) P83: Circumference of feed roller P85: Gear ratio	$P98_S = \frac{P83_M}{P85_M}$ [mm]

4.5.2 P143: Encoder pulses

Number of pulses per encoder revolution of the master axis.

4.5.3 Value range restrictions

Attention!

Check the value ranges of the dimensions M_T, P143, P98, S_T and P83.

$$\frac{M_T \bullet 4 \bullet P143}{P98} \leq 4\,000\,000$$

and

with P93 = 0 (Increments)

$$\frac{S_T \bullet 2^{16}}{P83} \leq 4\,000\,000$$

or

with P93 = 1 (mm) or 3 (degree).

$$\frac{S_T \bullet 2^{16}}{P83 \bullet 0{,}001} \leq 4\,000\,000$$

5 Encoder interface

The encoder interface serves for counting the master position.

By the encoder input (channel 1) the master movement is put in. The following parameters have to be adjusted:

P143: Encoder pulses of the encoder attached to the master axis.
P98: Distance of master axis per encoder revolution given in the units of the master (defined with cam editor).
P144: ="4": Synchronous operation by means of encoder channel 1.

6 Process coupling using HEDA (Option A1)

Synchronization and fast start with HEDA:

With HEDA (SSI interface), several axes can be synchronized to ±2.5µs precise simultaneous processing of individual controller time slices.
The Master (operating mode 1) sends 2 synchronization words to the slave axes to enable their synchronization. The slave axes (operating mode 2) control their own synchronicity. Feedback from the slave axes to the master does not occur.
The master only transmits to axis address 1. Therefore, all slaves must also be set to address 1 (P250=1).

⇨ Acyclic communication between master and slave is not possible.

Variant support:

COMPAX XX00M / S as slave to transmit the "Fast start" or as master
COMPAX XX60M / S as master or slave
(except where P212=3 or P212=4)
COMPAX XX70M / S as master or slave only with P31=9

Physical limits:

Max. 16 participants in the operating mode master/passive slave and max. 50m cable length.

Hardware requirements:

The devices must be fitted with options A1 (AIM5/02) or A3 (AIM5/03)! The last slave must be fitted with a bus 2/01 terminal plug.

HEDA parameters:

Parameter No.	Significance	valid from	Default value:
P243	HEDA operation mode	VP	0
P245*	Outputs O1 ... O8 assigned to HEDA bus	immediately	0
P246*	Outputs O9 ... O16 assigned to HEDA bus	immediately	0
P247	max. average errors in transmission	VP	5
P248	max. errors in transmission	VP	15
P249	Synchronization supervision	VP	10
P250	Device address (in master-slave operation =1)	VP	0

*In the operation modes HEDA master and HEDA slave (passive slave to COMPAX master), P245=P246=0.

Operation modes:

No.	P243	P250	Operation mode	Description
0	n.r.	= 0	independent single axis	no coupling, no synchronization
0	0	= 1 ... 9	Slave to IPM via HEDA	coupled operation and acyclic communication possible via HEDA
1	**Bit 0="1" (P243=1)**	**= 1**	**COMPAX as master**	**Master axis sends synchronising word and 7 words to address 1**
2	**Bit 1="1" (P243=2)**	**= 1**	**Passive slave to COMPAX master**	**Slave receives at address 1 (P250=1), but no feedback**

n.r. = not relevant

Transmission variable:

The master sends address 1 one data block per ms, consisting of

- Only standard device: HEDA control word including fast start on bit 8 (bit 8 is automatically generated in the master from I15 "Fast start").
- Process value, selected by parameter P184 and dependent on the family, (COMPAX XX00, COMPAX XX60, COMPAX XX70) between:

Output variable of master:

Output quantity	Master
◆ Encoder position (COMPAX XX70) + period duration master channel	P184=40
◆ Internal time base/encoder rate before P35* (COMPAX XX70)	P184=42
◆ Scaled master position before P35* (COMPAX XX70)	P184=43
◆ Position set point in resolver increments [65536 Increments/revolution]	P184=44
◆ Position actual value in resolver increments [65536 Increments/revolution]	P184=45
◆ Differentiated resolver position [Increments/ms]	P184=46

* The quantity is not influenced by P35.

Input variable of slave:

The slave is coupled with the transmitted quantities using P188.

Input quantity	Slave
◆ Encoder coupling (P184 on master =40) the input signal is used as the encoder signal.	P188=40
◆ Internal time base / encoder rate before P35* (COMPAX XX70) the input signal is used as the master rate. Application: Coupling of several axes to one master signal (e.g. an internal time base)	P188=42
◆ Scaled master position before P35* (COMPAX XX70) the input signal is used as the master position. Application: Coupling of several axes to one master signal (e.g. an internal time base)	P188=43
◆ Input quantity is interpreted as an encoder signal, but is not an encoder signal (P184 in master ≠ 40). For more detail see below.	P188=140

* The quantity can be influenced by P35.

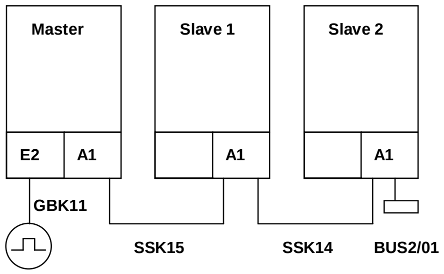
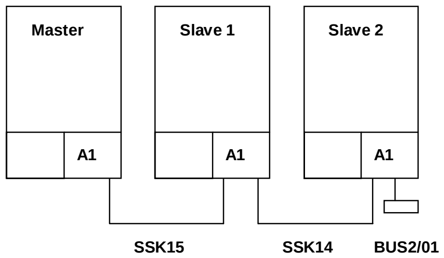
Permissible combinations and the required parameter settings:

Master output quantity: P184=	Slave input quantity: P188=	Applicable for slave device variants:	Settings in the master and slave to match process quantities: **P98 identical for all devices.**
40 (CPX 00 CPX 60, CPX 70)	40	CPX 60, CPX 70	$P143_s$=$P143_M$[1]
	43	CPX 70	
42 (CPX 70)	42	CPX 70	$P143_s$=$P143_M$
43 (CPX 70)	140*	CPX 60, CPX 70	$P143_s$=$P143_M$
	43	CPX 70	
44 (CPX 00 CPX 60, CPX 70)	140*	CPX 60, CPX 70	$P143_s = 2^{14} = 16384$
	43	CPX 70	
45 (CPX 00 CPX 60, CPX 70)	140*	CPX 60, CPX 70	$P143_s = 2^{14} = 16384$
	43	CPX 70	
46 (CPX 00 CPX 60, CPX 70)	42	CPX 70	$P143_s$=$P143_M$

* When transmitting the encoder position P184=40, the encoder position is transferred in High-Word and the period duration in Low-Word in order to support the period duration measurement of the slave.
Where a combination of applications is applicable, e.g. master P184=44 (Position set point) and slave with encoder coupling, the slave must be informed using P188=140 (in this case, only the High-Word is evaluated).

[1] $P143_S$: Parameter P143 of the slave
$P143_M$: Parameter P143 of the master

Application examples:

	1st device: Master	Slave
Coupling of several axes to one encoder; signals distributed via HEDA 	COMPAX XX60 COMPAX XX70 (P31=1) Encoder input P184=40 (Encoder position + period duration) P188=40 P98 and P143 must have identical values in the master and slave!	COMPAX XX60 COMPAX XX70 (P31=9) P188=40 (Encoder input; period duration available)
Replacement of encoder simulation by HEDA bus 	COMPAX XX00 COMPAX XX60 COMPAX XX70 P184=44 (Position set point) or P184=45 (Position actual point) P188=0	COMPAX XX60 COMPAX XX70 P188=140 Settings: P143 = 16384 (P143 always displays ¼ of the increments, as quadrupling occurs in the encoder inputs)
Coupling of several cams with common time bases and separate master or slave related label synchronization (see above)	COMPAX XX70 P184=42 (Time base) P188=42	COMPAX XX70 P188=42 $P143_S$=$P143_M$
Coupling of several cams with common time bases and absolute driftfreeness between the axes through transmission of a position value (see above)	COMPAX XX70 P184=43 (Scaled master position) P188=43	COMPAX XX70 P188=43 $P143_S$=$P143_M$

Error handling

Only position signals can be completely restored following HEDA errors in transmission. When transmitting rates, errors in transmission can lead to drift occuring between the axis positions. **Position values should therefore be used.**

Error messages:

HEDA transmission or synchronization errors are Errors E76, E77 and E78 (see the Error list in the User Guide).

E76:

Synchronization is interrupted with E76, therefore an alignment is implemented where the process position value is aligned in such a manner that a position leap does not occur.

E77/E78:

With E77/E78, the slave attempts to reach the new undisturbed process position value in order to maintain the reference system.

Attention!

Sending "VC" interrupts the synchronization.
Only activate "VC" in the unpowered condition.
When working with the user terminal BDF2, "VC" is sent when the Menu "Parameter edit" is quitted.

Procedures for errors in transmission:

Position values / Position (P184=40/43/44/45):	linear interpolation using old values
Speed values / frequency (P184=42/46):	Old value retained

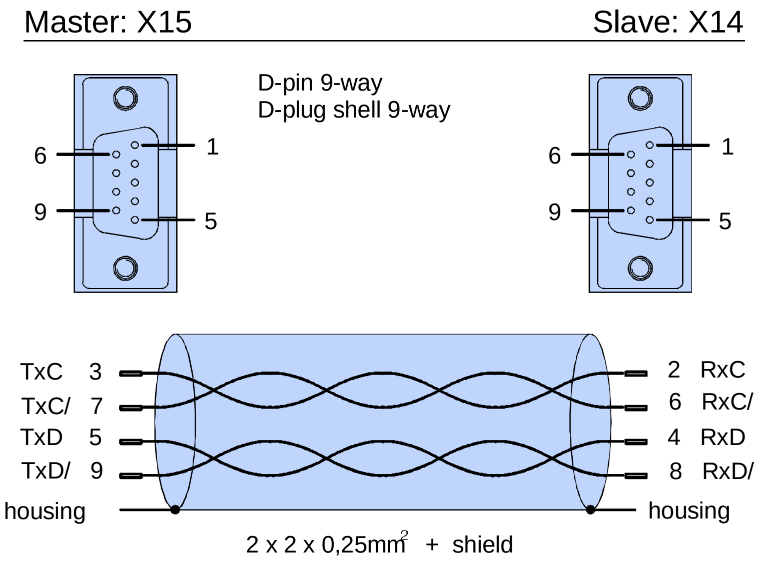
Synchronization of process values:

On the master side, when P188>0 occurs, a 2ms fixed delay is implemented on the relevant process value so that the master waits until all axes have received the process value. This ensures that all axes, including the master, process new set points simultaneously.

Notes:	◆ Apart from the fast start, no further I/As are transmitted. ◆ Only one master is permitted on the bus!
Note:	◆ The position values with P184=44 and P184=45 are formed independently of the current positioning operating mode (normal, endless, reset) from position set points or actual values, and are held ready in 24 Bit format as if they were in counter channels. This avoids rapid changes in the start moment (in endless operation) or when reaching the curve end (in reset mode). Only the bottom 24 Bits of these values are transmitted, consisting of the resolver value and maximum 256 motor revolutions.
COMPAX XX70	◆ Due to the manipulations in the counter channel in connection with the increment precise master position enabling (Preset at I16=0->1 or external reset pulse), a new operation mode P31 =9 was formed for the HEDA operation, where I16 is only used for the statical enabling of the master position and not for resetting the counter channel. This operation mode (P31=9) must be used with the master and slave, when an encoder connection is implemented (master: P184=40; slave P188=40 or 140).

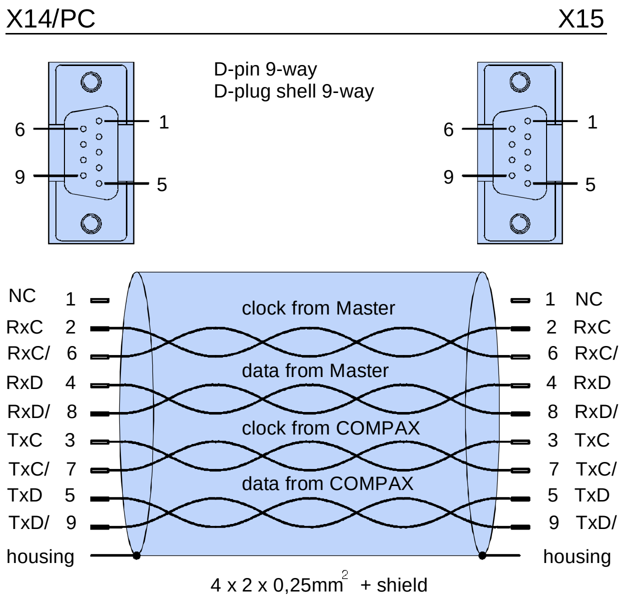
Cable for master-slave coupling:

SSK15/..



Cable for slave-slave coupling:

SSK14/..



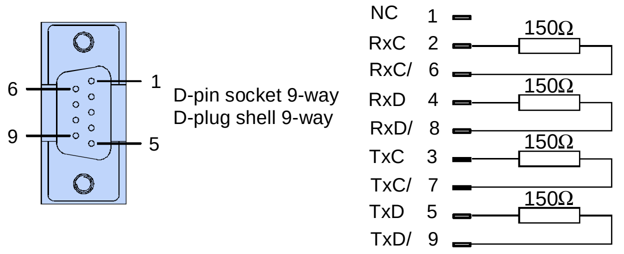
The cables are paired stranded cables! The screening must be attached on both sides!

This cable can only be used when all slaves are operated in the operation mode P243=2. Otherwise the slaves transmit back to the same address which can in the long term damage the Option A1 drivers.

Terminal plug

The last device is fitted with a terminal plug: BUS2/01

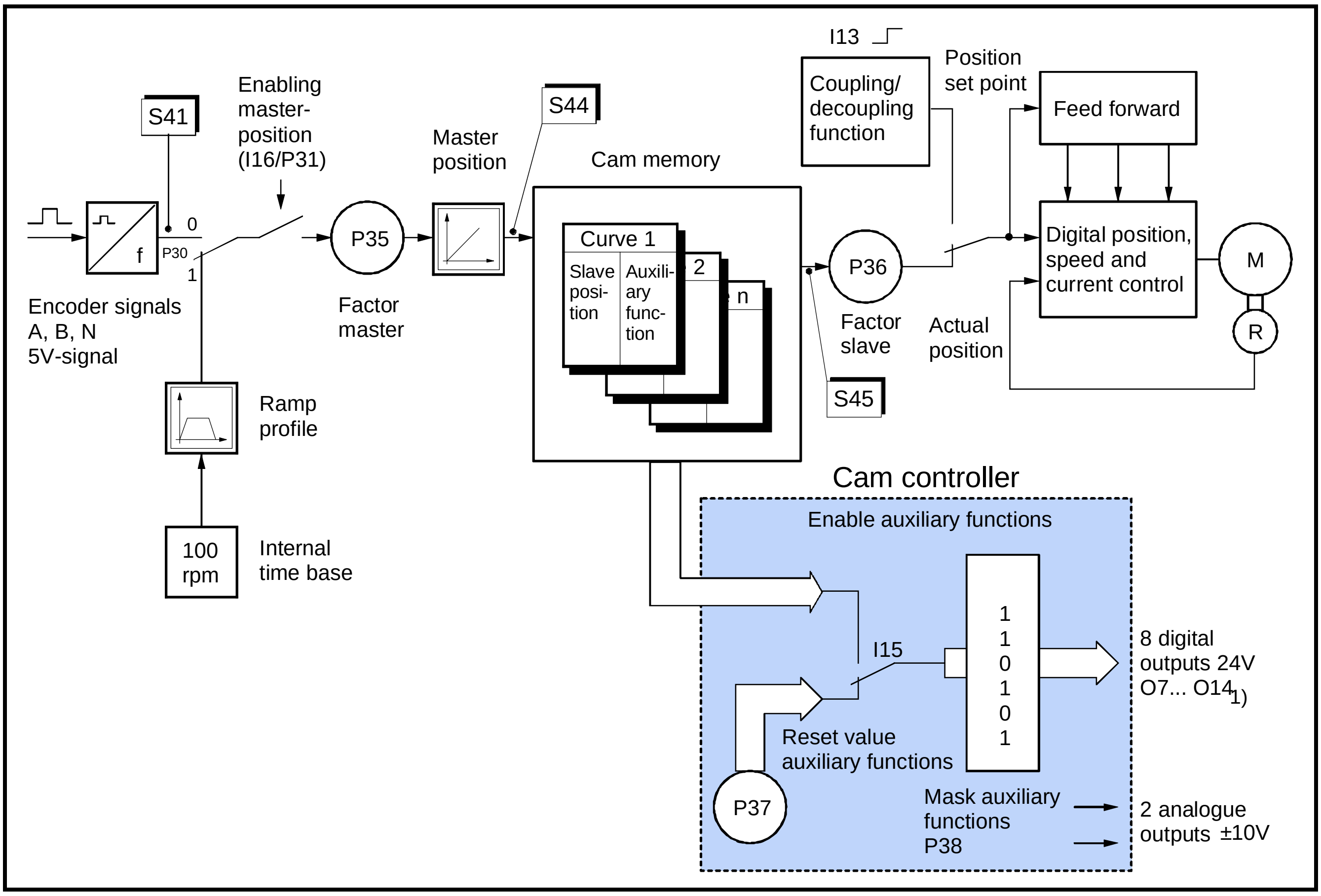
X15 BUS 2/01



7 Block structure

The following block structure contains several cam functions:

- The left side shows how the master position can be formed.
- In the middle the cam memory is shown symbolically.
- On the right you can see how the set point ist generated. The coupling- and decoupling-functions are only pictured as a block. On the right side there is also shown the cam controller with its auxiliary functions, digital and analogous-outputs.



1) O14 can only be used at P33="0" as an auxiliary function.

O13 and O14 cannot be used by means of the OUTPUT-command.

Between the position values of the set point memory COMPAX XX70 calculates intermediate values by means of a linear interpolation.

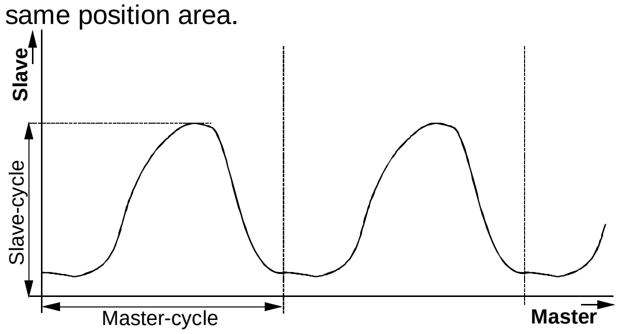
8 Curve Definition

8.1 Curve type

There are two main curve types:

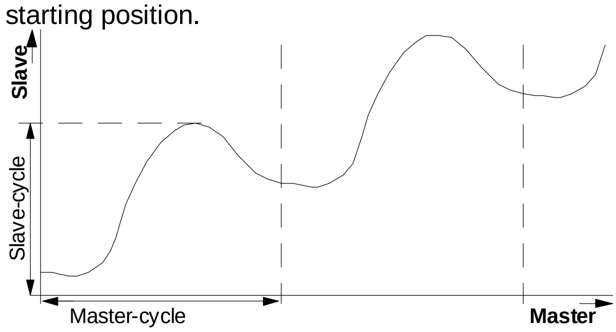
- **Closed curves**

The starting and the end-position of the slave are identical i.e. the slave always moves within the same position area.

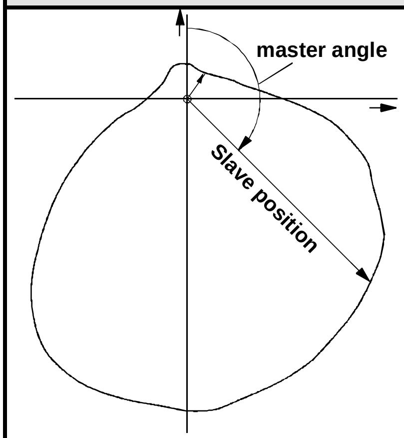
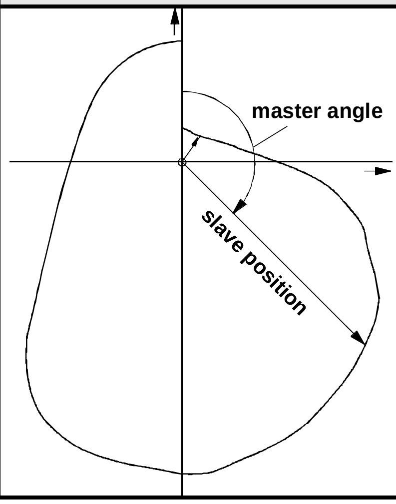


- **Open curves**

The starting and the end-position of the slave are not identical. I.e. the slave moves in one direction, as at the end of the curve the actual position of the slave will principally be adjusted to the curve's starting position.



Curves in polar depiction:

closed curve	open curve
	

8.2 Curve Parameters

The curve parameters described in the following are not COMPAX-parameters. They are curve-specific and are stored within each curve. These are set using the cam editor (see next chapter) or directly using the appropriate ASCII string via RS232 (see page 59) oder Bus.

Master cycle (M_T):

The master cycle is the distance which is travelled by the master within one curve i. e. the distance after which a new cycle recurs. This distance is indicated by the physical unit of the master.
After this distance the curve profile will either be repeated or the cam operation will be interrupted, after a programmed number of curve travels has been reached.

Slave cycle (S_T):

The slave cycle is the max. travel distance of the slave indicated by the physical unit of the slave. The slave cycle always corresponds to the max. curve value.

Coupling position (M_E):

With P34="1", the master must reach the coupling position M_E before the coupling process can be started (see page 24).
At P34="0", the coupling position M_E is insignificant.
Value range of M_E:
M_E= 0 or ≥ the maximum master position change in 1ms.
The coupling position is not recognised anywhere inbetween.

Synchronous position (M_S):

The coupling process is finished i. e. the slave is synchronous to the curve after the master has reached the synchronous position M_s.

Decoupling position (M_A):

With P34="1", the master must reach the decoupling position M_A before the decoupling process can be started (see page 24).
At P34="0" the decoupling position M_A is insignificant.

Braking position (M_B):

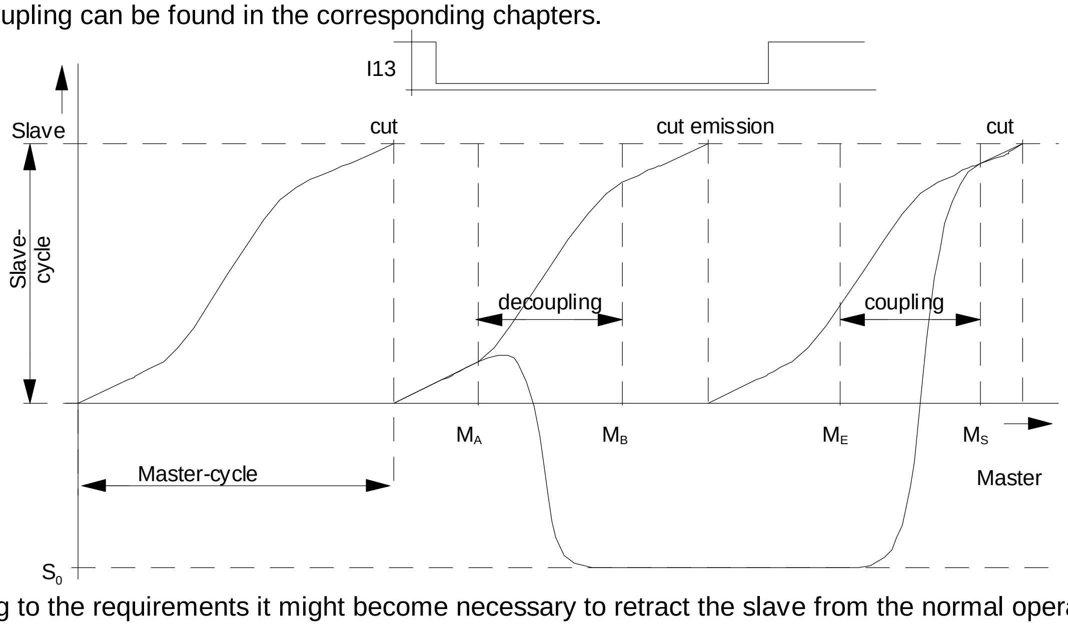
After decoupling the slave stops at this master position.

Standstill position, slave (S_0):

This slave position will be reached by the slave axis after decoupling. Value range: $\pm S_T$.

Example

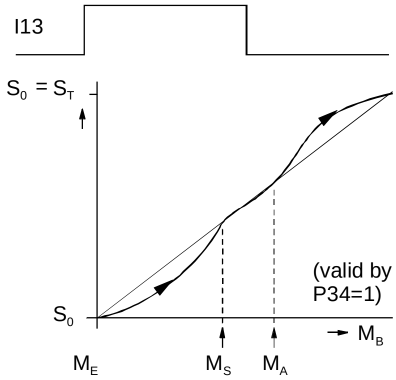
The picture below shows an example for the coupling parameters. Detailed descriptions concerning coupling and decoupling can be found in the corresponding chapters.



According to the requirements it might become necessary to retract the slave from the normal operation field (retraction). This function can be carried out by the standstill position S0.

8.2.1 Exception $S_0 = S_T$

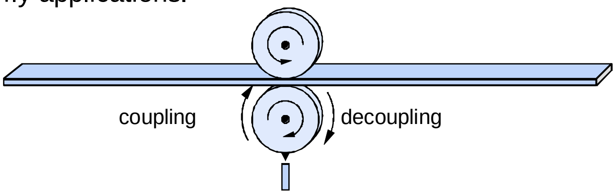
In case of the standstill position S_0 being equal to the slave cycle there is an exception:



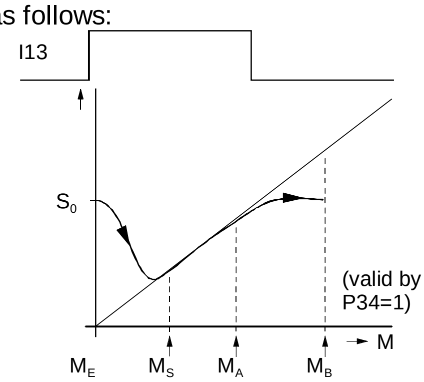
Then the following applies:

- Decoupling on position $S_0 = S_T$.
- Coupling from 0.

This results in a continuous forward movement of the slave which is indispensable in cutting on the fly applications.



In all other cases i. e. $0 \leq S_0 < S_T$ the coupling profile is as follows:



8.3 Curve Figuration by using the Cam Editor

The 2500 addresses of the cam memory can be programmed by one or several curves. Each curve set point can be given auxiliary functions (8 digital and 2 analogous outputs).

Figuration of the curves

Use the HAUSER - Cam-Editor for configuring the curves. This is a windows program which offers all advantages of a windows application.
The curves can also be loaded into the COMPAX using the Cam-Editor.

Description for use of Cam-editor will be given in a separate instruction manual!

Additional notes on the cam memory can be found on page 59!

9 Curve Commands

In order to involve the electronical cam in a COMPAX program the standard command set (see User Guide COMPAX-M/S) is to be complemented by the following instructions:

SETC n

Short: SC n

Command entry in BDF2: F1

Curve selection. By means of SETC n you select the "n"th curve of the cam memory.

Range: according to the number of curves in memory (max. 100 curves with 2 set points each).

Example: SETC 2 The 2nd curve of the cam memory will be selected.

SETM x

Short: SM x

Command entry in BDF2: F2

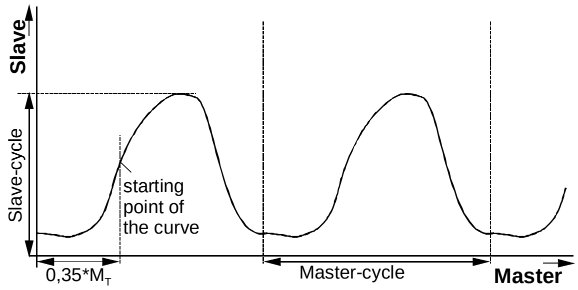
Selection of master starting point. The master starting point is given in % with reference to the master cycle. The actual master position is put on the value "(x/100)* master cycle".

Range: 0.000...100.000; which corresponds to the scaled master cycle. Without the command"SETM x" the curve would start according to the actual master position.

⇨ Please bear in mind that by this command you will only receive a defined starting point if there is a constant master position.

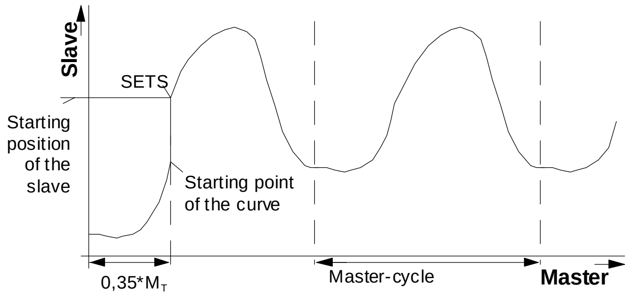
Example: SETC 2 The 2nd curve of the cam memory will be selected.

SETM 35 The actual master position is set to 35% of the master cycle.



⇨ **This command only becomes efficient after a curve has been selected. Exception: SETM 0: the master starting point is adjusted to 0.**

⇨ **SETM interrupts a current master related label synchronization!**

<table>
<tr><td rowspan="3">SETS
Short: SS
Command input on BDF2: F3</td>
<td>Adjustment of curve starting point. The curve starting point is adjusted in accordance with the master position. The curve will be shifted which does not result in any slave movement.
Please bear in mind that by this command you will only receive a defined starting point if there is a constant master position.</td></tr>
<tr><td>Example: SETC 2 — The 2nd curve of the cam memory will be selected.
SETM 35 — The actual master position is set to 35% of the master cycle.
SETS — The slave position is adjusted to the curve position. The slave does not move.

</td></tr>
<tr><td>This command only becomes efficient after a curve has been selected.</td></tr>
</table>

The commands SETC n, SETM x and LOOP m may also refer to the operation parameters; (P40...P49); i. e. SETC .P40, SETM .P40, LOOP .P40.

POSR CAM

Short: PR

(without argument)

Command input on BDF2: POSR (no variable)

Travel to the actual slave position (acc. to master position) of the curve

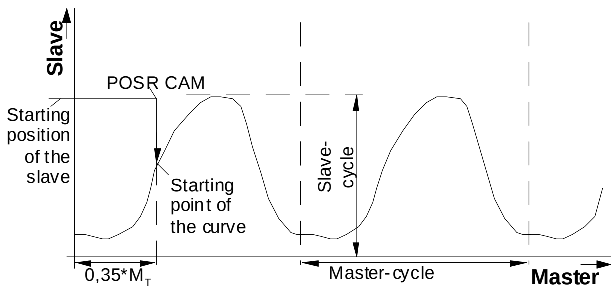
With this command you can prepare the cam operation.

- The slave travels to the slave position which corresponds to the actual master position.
- This might be:
  - The starting position of the selected curve if the master position is 0 (which means for example that the increments have not yet been counted) or after SETM 0.
  - Any master starting point which was selected by SETM x.
  - The actual master position.

⇨ Please bear in mind that by this command you will only receive a defined starting point if there is a constant master position (disabled master position measurement i. e. stopped time base).

⇨ Set P1=0!

Example:	SETC 2	The 2nd curve of the cam memory will be selected.
	SETM 35	The actual master position is set to 35% of the master cycle.
	POSR CAM	By a normal positioning (with the values adjusted by means of ACCEL and SPEED) the slave will travel to the slave position which corresponds to the chosen master starting point.



⇨ This command only becomes efficient after a curve has been selected.

Note regarding endless operation

In endless operation, the slave moves a relative distance based on the current position, corresponding to the actual slave set point.
Reason: The actual position is set to 0 at the beginning of each positioning, even with POSR CAM.

LOOP m

Short: LP m

Command input on BDF2: F4

Activation of cam operation. After this command the slave is ready to start the cam operation and to travel it "m" times. Range: 0...65000.

- The actual start will be initiated by I13="1" according to the chosen coupling conditions (see page24) .
- after the curve has been travelled m-times, it is stopped in accordance with the selected decoupling conditions (see page 24) angehalten.
- The loops will be counted (status of the loop counter = S48) as soon as the coupling procedure is finished and the slave is at synchronous operation (O16="1").
- **Exception:** By the command LOOP 0 the curve will be travelled cyclically and can only be interrupted by STOP.

Remark:

Comparator functions (POSR OUTPUT und POSR SPEED) are not possible with the LOOP command.

Example: LOOP 10 After the selected curve has been started it will be travelled 10 times.

⇨ This command only becomes efficient after a curve has been selected.

⇨ During the cam operation, input I12 is not evaluated.

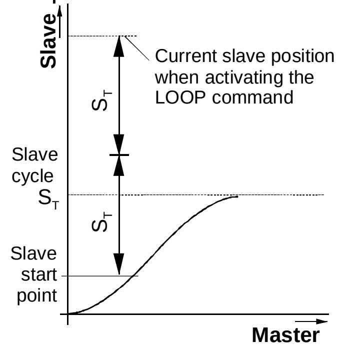
Slave position at curve start

If, prior to the LOOP command, slave compensation via SETS or POSR CAM is not implemented, the slave start point in the curve is calculated as follows:

If the slave position, when activating the LOOP command, is outside the slave cycle, then the "Modulo" is back-calculated in the slave cycle, i.e. the slave cycle is moved from the current slave position until the result lies within the the slave cycle.

This slave position is then the slave start point in the curve, from which the coupling movement is started with the first coupling after LOOP.

Example:



Note regarding LOOP 1

A curve is designated as processed, when it has been completely travelled once synchronously (O16=1 during the whole cycle).
If coupling/decoupling profiles are used, then it is possible that more than one curve cycle is travelled in LOOP 1.

10 Start up synchronization

After "Power On" to COMPAX 70 you have to establish:

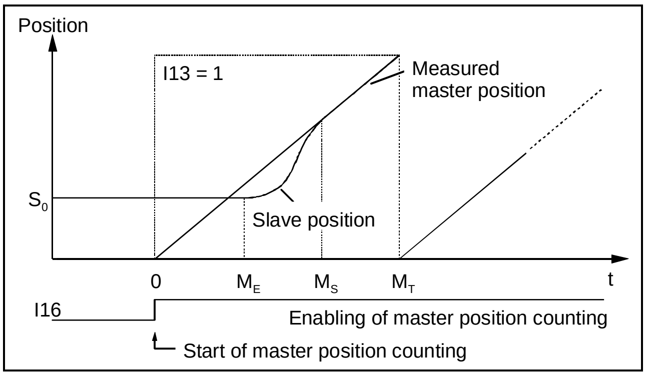
- the reference of the actual master position to the curve and
- the reference of the slave position to the curve.

10.1 Reference of the Master Position to the Curve

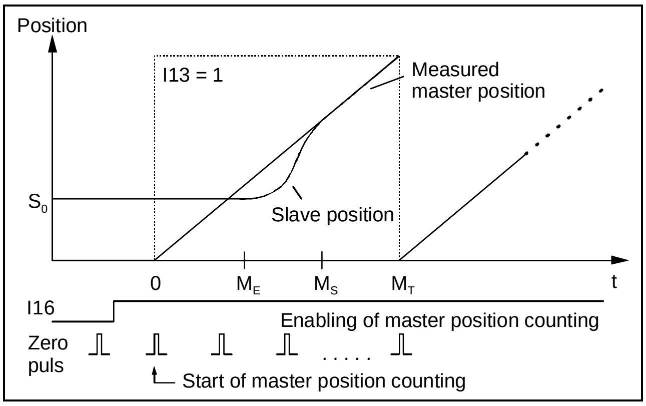
As a first step the master position measurement must be enabled in such a way that the determined master position corresponds to the respective curve points.
Two initial conditions are to be distinguished:

1. **Stationary master**
   - After SETC n the master must be brought to the actual master position by SETM x.
   - Enabling of master position measurement per example by P31=0 and I16="1".
2. **Travelling master**
   - After SETC n, specifically enable the master position measurement.

   a) Statical by I16 (P31="0") or by edge (P31="2")

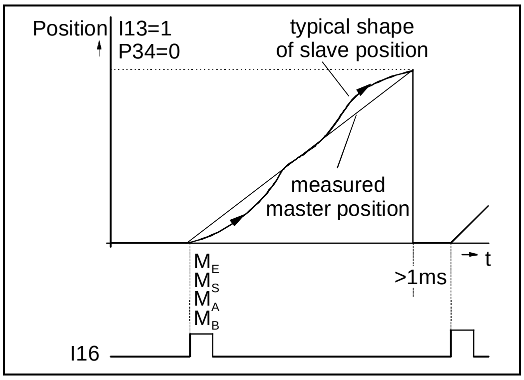


   b) Statical by I16 and by means of the next edge of the encoder zero pulse (P31="1").



   c) Edge-triggered of I16 for a single master cycle (P31="3").

Application: asynchronous starting of a curve e. g. if a curve is to be travelled that refers to a product which is plaud on a belt at different distances.

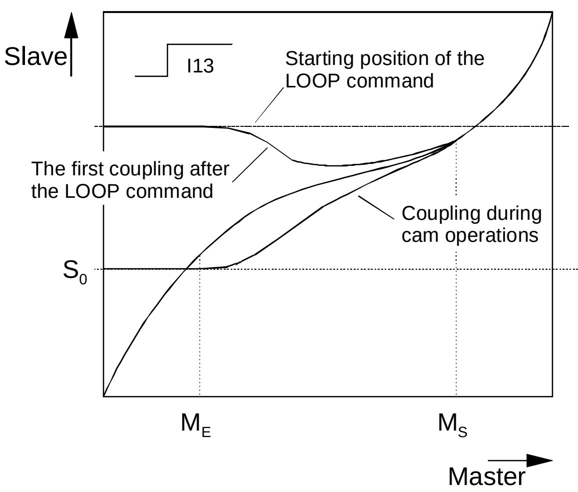


See also in chapter 19.1 Function of Inputs (page 47).

11 Synchronization on the Fly

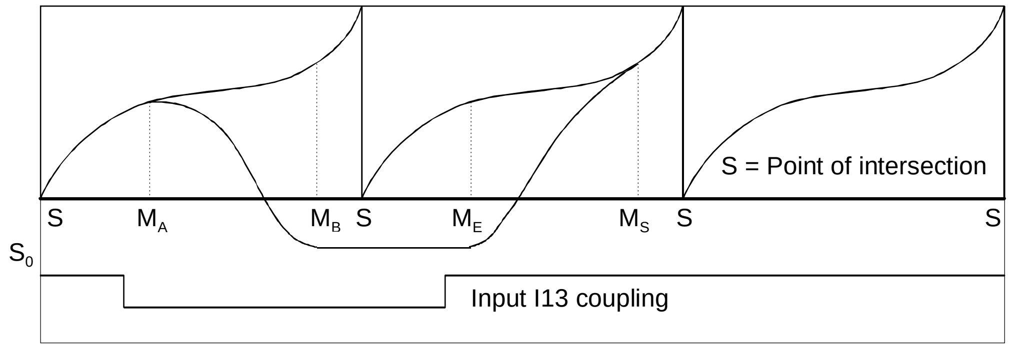
Coupling and decoupling is only possible with an rising master (S44 rising)!

- Using the function "coupling", the slave is synchronised from the current position on the curve. This coupling motion is started by the input I13 (I13="1"). By means of the curve parameters "coupling position" (M_E) and "synchronous position" (M_S) you may have an influence on the coupling profile.
- Using the function "Decoupling", the slave is taken out of synchronous operation into the standstill position S_0. Decoupling can be initiated by the input I13 (I13="0") By the curve parameters "decoupling position" (M_A) and "braking point" (M_B) you may have an influence on the decoupling profile.



S_O = Standstill position	I13 = Input coupling
M_E = Coupling position	M_A = Decoupling position
M_S = Synchronous position	M_B = Breaking point

Example: retraction of material at product default



11.1 Starting of a Curve / Coupling

- Coupling into a curve can only occur if the slave is at a standstill when the coupling procedure is activated.
- Coupling only occurs, with one exception (where M_E=M_S=0 and P34="0"), when the master movement is in the positive direction (S46="0").
- The coupling modes are illustrated by means of a simple linear curve and must be preceded by the following program:

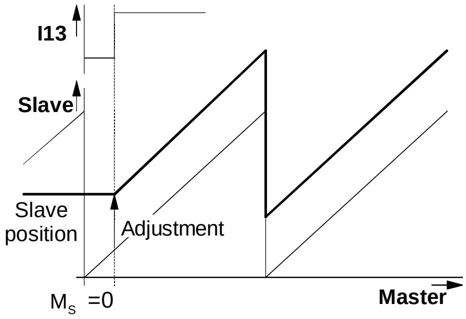
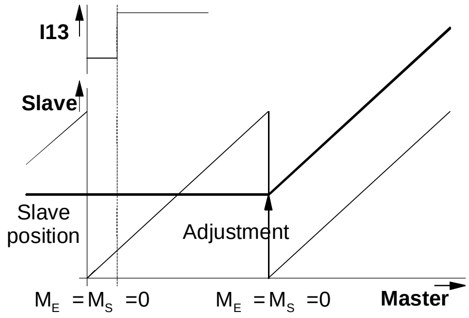
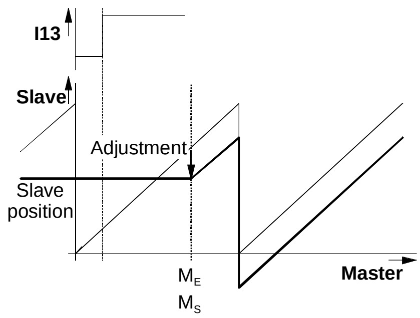
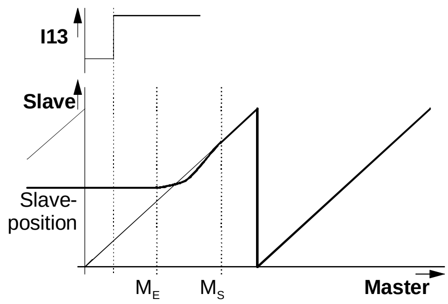
  SETC 1 selection of desired curve e. g. 1st curve.

  (SETM x) by this command the master position can be given a defined value. This command, however, is not imperative.

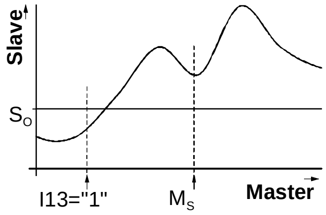
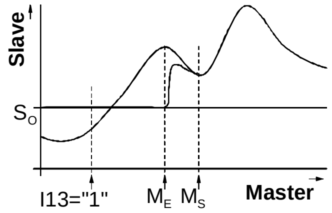
  LOOP 10 Cam operation e. g. activated for 10 loops.

By the commands SETS and POSR CAM the starting operation of the coupling procedure can additionally be influenced before the LOOP-command is given.

11.1.1 Coupling modes

	P34="0": coupling by I13="1"only. (Bit 0) **No consideration of ME**	**P34="1": coupling by I13="1" and after coupling position ME has been reached** (Bit 0)
ME = MS = 0 If the master is moving (see following curve) the slave has to bear a speed leap at the curve start. It consequently will start jerkily.	 By I13="1" there will be carried out an automatic curve adjustment i. e. the actual slave position will be equated with the actual curve position of the slave (slave does not travel). In this setting, the slave can be coupled even if the master movement is negative.	 By I13="1" an automatic curve adjustment will be carried out at the beginning of the next master cycle (as ME=M**S**=0).
ME = MS ≠ 0	**Attention!** **With these settings, rapid coupling movements are possible!** This can trigger Error E10 (tracking error).	 After I13="1", the slave waits for the master position ME and then immediately follows the curve synchronously with an automatic curve compensation. At this type of curve there will occur a leap of the rotational speed.
ME ≠ MS **Condition:** **ME < MS**		 After I13="1", the slave waits until the master position ME before beginning with the coupling procedure. At the master position MS, the slave is synchronous with the curve.

In case of the actual slave position exceeding the slave cycle at the moment of the curve entering (LOOP) both the set position and the actual position are counted back by n*S_T .

Attention!	**Coupling not possible! (P34="0")**	**Coupling possible with the position of M_E (P34="1")**
The following conditions have to be considered: ◆ between starting and ending the coupling procedure the curve must not show an extreme value (see example on the right).		

Note: A very small coupling position (M_E) or decoupling position (M_A) may not be recognised.
Problem: If the coupling or decoupling position lies close to zero, it is possible that in the cyclical curve mode only values > M_E or > M_A are read when measuring the master position. If M_E or M_A is not undershot, then the coupling position or the decoupling position is not recognised.
Solution: Increase M_E or M_A to a recognised value.
Exception: M_E = 0 or M_A = 0 is evaluated separately and is therefore always recognised.

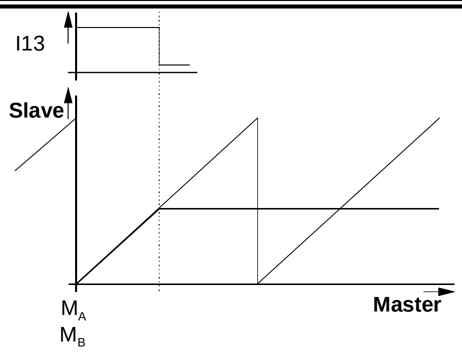
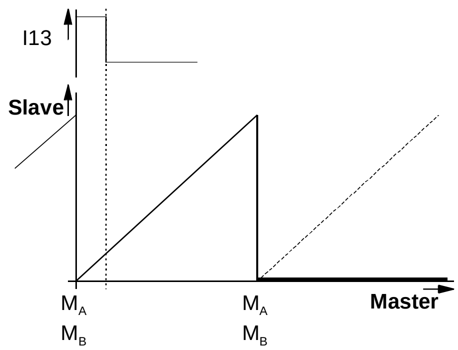
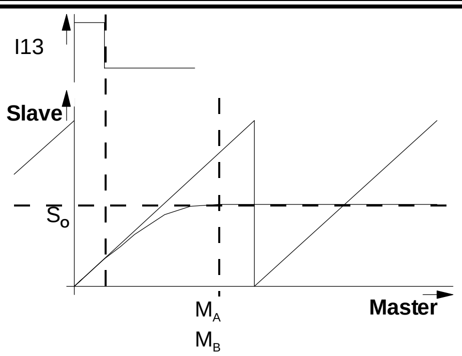
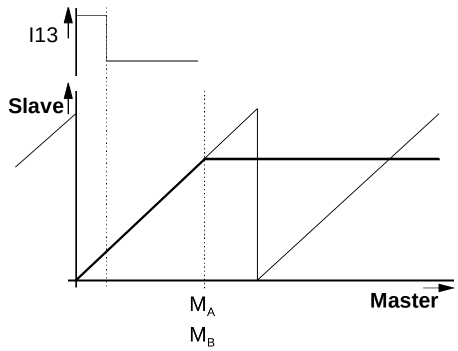
11.2 Stopping of a Curve /Decoupling

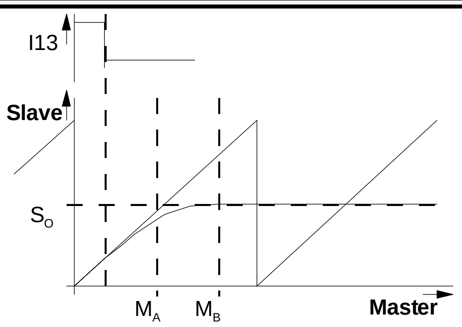
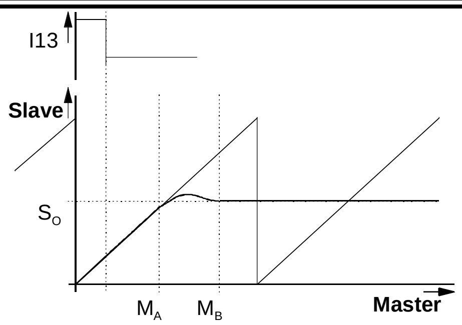
Note that after decoupling using I13="0", COMPAX remains in the "Curve ready" mode. I. e.:

- the LOOP - command is still active and COMPAX does not carry out any commands.
- COMPAX only reacts on: STOP or BREAK-signal and I13="1" (coupling)

The curve is only terminated by decoupling after the LOOP-command has been carried out. COMPAX is now ready to receive further commands.
Exception: If the curve commands are specified via an interface (not as a set command), COMPAX also reacts during the cam operation to the command "POSA HOME" or Shift I2.

11.2.1 Decoupling Modes

	P34="0": decoupling by I13="0" only, without consideration of M_A.	**P34="1": decoupling by I13="0" and after reaching decoupling position M_A**
$M_A = M_B = 0$ At the shown curves the slave gets a leap of the rotational speed while decoupling i. e. it will stop jerkily. **The standstill position S_0 is not taken into consideration at $M_A = M_B = 0$.**	 By I13="0" the slave can be stopped immediately. In this case, the slave can also decouple when the master movement is negative.	 By I13="0" the slave will only be stopped at the beginning of the next master cycle (as $M_A = M_B = 0$)
$M_A = M_B \neq 0$	 By I13="0" the decoupling is started. At the master position M_B the slave is on standstill position S_0.	 After I13="0" the slave waits for the master position M_A and then will stop jerkily. A leap of the rotational speed will occur.

	P34="0": decoupling by I13="0" only, without consideration of M_A.	**P34="1": decoupling by I13="0" and after reaching decoupling position M_A**
$M_A \neq M_B$ **Condition:** **$M_A < M_B$**	 By I13="0" the decoupling is started. At the master position M_B the slave is on standstill position S_0.	 After I13="0" the slave waits for the master position M_A before it will start its decoupling process. At the master position M_B the slave is on standstill position S_0.

⇨ The usual adjustments are shown on the double framed figures. On the remaining ones there are shown special cases.

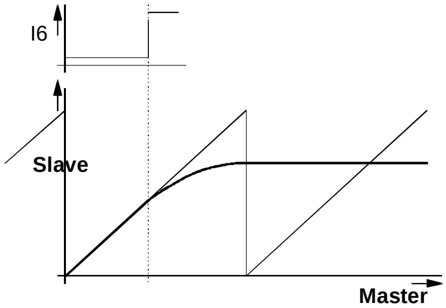
The above cases are also valid if the slave terminates the cam operation after the LOOP-command has been carried out, i. e. the loop counter reaches zero.

12 Additional operation modes for decoupling

P34 = 2 or 3 (Bit 1 in P34): "Leave curve mode after decoupling".
The curve mode can be left, regardless of the condition of the loop counter, without implementing a stop. The next positioning command is then processed when the decoupling movement is terminated.

12.0.1 Curve Interruption by "STOP" "EMERGENCY-STOP" or "BREAK"

Stop interrupts the cam operation and brings the slave to a standstill via a ramp (using the ramp time defined by ACCEL(-) or the reserve time P6), producing an undefined target position.



As a further step the next command will be used in the program memory.

New entry into the curve

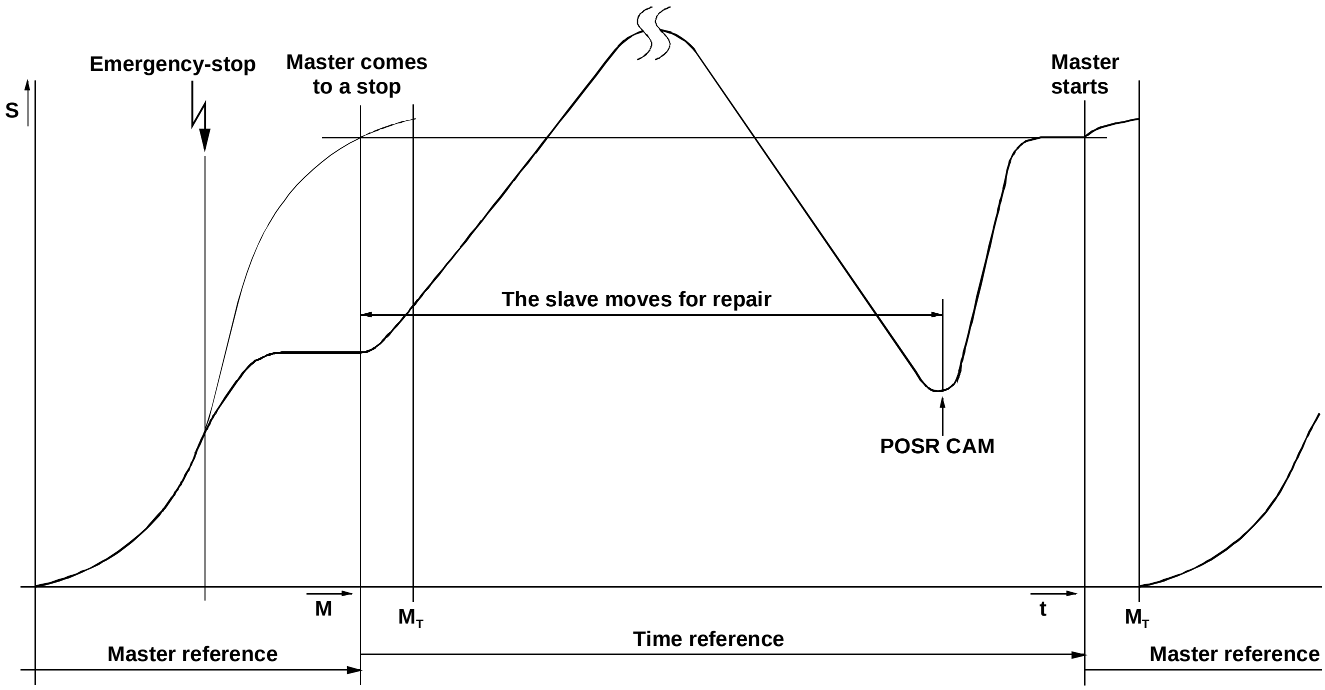
The new entry into the curve after an interruption must be implemented by a new curve entry.

With a defined coupling position ($M_E < M_S$ and P34="1"), entry into the curve occurs via a coupling movement.

If no coupling procedure has been defined ($M_E = M_S$ and P34="0"), it is possible to align the slave position so that a seamless entry occurs.

For this purpose, the slave must be reset before the master starts up on the curve again.

Graphic representation:



Procedure:

- Slave and master are stopped using the emergency stop.
- The slave is moved for repair.
- The unit must be started.
- Move slave using the command POSR CAM to the curve value which correpsonds to the actual master position.
  - In normal and reset mode, the slave returns to the correct curve value from any position.
  - In endless operation, this only occurs when the slave lies within the slave cycle.
- If the master now starts up, the slave will start up simultaneously.

13 Auxiliary functions

By means of the auxiliary functions there can be initiated set point related actions.

13.1 Digital Outputs

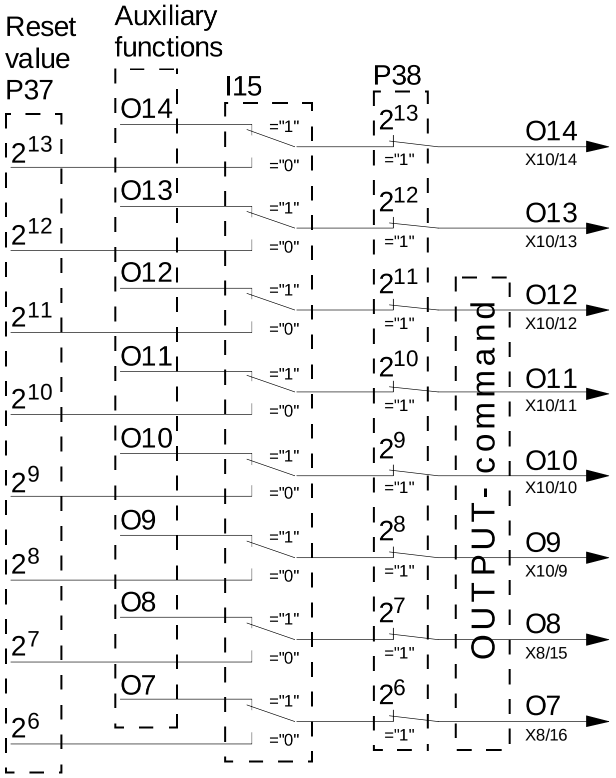
The digital outputs O7 to O14 will serve as auxiliary functions.

They can be:

- using parameter P38, masked (switched off individually) and
- enabled (I15="1") and disabled (I15="0") by the digital input I15.

A reset value can be allocated to the switched off digital auxiliary functions using Parameter P37.

For the functional connection please see the following structure:



- Beyond cam operation (by LOOP n) the outputs O7 to O12 are accessible by OUTPUT which is independant of the mask.
- During cam operation only those outputs are modified by the auxiliary functions which are enabled by P38.
- O13 and O14 cannot be reached by OUTPUT. This is only possible by the auxiliary functions.
- If the label synchronization is switched on (P33≠ 0) O14 is engaged, with the signal "label error".

When leaving the synchronous operation:

- by I13="0",

i. e. when leaving the cam operation

- by STOP,
- by BREAK or
- after the occurrence of an error

the outputs will remain at the status which has been indicated last. They only change on receiving the command "OUTPUT" or if they are influenced at the next cam operation.

13.1.1 Masking of the digital Auxiliary Functions by P38

Auxiliary Function	P38 Valence	Enabling	Disabling	Value
O7	2^6	64	0	
O8	2^7	128	0	
O9	2^8	256	0	
O10	2^9	512	0	
O11	2^{10}	1024	0	
O12	2^{11}	2048	0	
O13	2^{12}	4096	0	
O14	2^{13}	8192	0	
			Total:	

⇨ O7...O14 to be enabled by P38=16320

13.1.2 Reset value of the digital auxiliary functions using P37

Auxiliary Function	P37 Valence	="1"	="0"	Value
O7	2^6	64	0	
O8	2^7	128	0	
O9	2^8	256	0	
O10	2^9	512	0	
O11	2^{10}	1024	0	
O12	2^{11}	2048	0	
O13	2^{12}	4096	0	
O14	2^{13}	8192	0	
			Total:	

13.2 Analogous Outputs

Using the standard service D/A-Monitor or the D/A-Monitor Option (Option D1), it is possible to produce 5 curve related quantities as analogue values:

- 2 auxiliary functions
  The curve related auxiliary functions are entered in the CamEditor. Each master position can have a defined output value.
- The master position
- The slave position
- The master rotation speed

Between the set points the analogous value of the auxiliary functions is calculated by means of a linear interpolation.

Extended selection for the D/A-Monitor:

In addition to the output quantity 1 ... 18 (see User Guide COMPAX), the following quantities are possible:

Signal no.	Measuring value	Max. output value with gain =1
20	Analogue 0 (defined in CamEditor)	100%≡100mV
21	Analogue 1 (defined in CamEditor)	100%≡100mV
22	Scaled master position during cam operation.	M_T≡100mV
23	Scaled slave position during cam operation.	S_T≡100mV
24	Rotational speed of master	20000min^{-1}≡ 10V

Output via the service D/A-Monitor

Allocation of the channels

channel 2: X11/4; channel 3: X11/5

Setting the channels via P76 and P77

No.	Parameter	Range
P76 Pre-comma value	Output quantity from channel 2.	0...16
P76 Post-comma value[2]	Gain factor from channel 2. (factor = value x 10 000 000)	0.1... 10 000 0 00
P77 Pre-comma value	Output quantity from channel 3.	0...18
P77 Post-comma value	Gain factor from channel 3. (factor = value x 10 000 000)	0.1... 10 000 0 00

The parameters can only be addressed after the password has been entered.

Additional explanations can be found in the COMPAX-M/S User Guide.

Output via the D1-Option

Set using P71 ... P74.

By the gain factors

- **P71**: channel 0 (adressed by P73) (plug: X17/1-X17/6) and
- **P72**: channel 1 (adressed by P74) (plug: X17/2-X17/6)

you are able to adapt the output range limited to 10V.

Examples:

P73 output: X17/1-6	**P71=10**	**P71=100**
P74 output: X17/2-6	**P72=10**	**P72=100**
20	100%≡1V	100%≡10V
21	100%≡1V	100%≡10V
22	M_T≡1V	M_T≡10V
23	S_T≡1V	S_T≡10V
24	2000min^{-1}≡10V	200min^{-1}≡10V

During the activation (after "Power-On") the analogous output is 10V.

For more information on the D/A-Monitor, see COMPAX User Guide.

Note

The auxiliary functions do not only refer to a fix master position but also to a fix slave position. The exact reference concerning the slave position will get lost by correction measures if you use a slave related label synchronization (see next page).

2 0.0000001=factor 1
0.000001=factor 10
0.999999=factor 10 000 000

14 Label synchronization

Label synchronization can only be operated with an increasing master (S44 increasing)!

In the packaging and printing industry a synchronization of slave axis to print labels is often necessary in order to align for material slip (where the label sensor must be fitted close to the master: see below, under Error correction).
If the master position (or the slave position) counted by the slave is corrected by the calculated slip between product and label sensor, the error can be aligned for before the next label appears.
The online label synchronization in COMPAX XX70 has the following characteristics:

- Operation modes: Master or slave related.
- Label signal evaluation using a signal to I14 (I14="1") in the 100µs cycle.
- Allocation of label position and type of correction with
  - 2 COMPAX parameters (P32, P33) and
  - 4 curve parameters; these are parametrized by the CamEditor together with the curve.
- Enabling and disabling the label synchronization with parameter P33 (see page 36).
- Default setting of label sensor distance with parameter P32 "Distance of label sensor"

The following parameters must be set here:

14.1 P32: Distance of label sensor

The "Distance of label sensor" is the distance between label sensor and the processing point or the point where processing begins. P32 must be set using the same units as the allocated cycle.
These parameters can be used to correct the label sensor during start-up.
P32 is set to valid with VP.

Attention!

An online modification of P32 is only permitted within the label window M_F. I.e., P32 can only be modified by a maximum of < M_F steps per cycle. Generally, larger modifications cause the label to fall out of the label window.

Error correction

Any error detected by the label sensor is corrected in the next cycle; i. e. a shift in label distance in the current cycle can only be corrected when P32 << M_T.

P32 acceptance

Any modification of P32 (and P33) becomes valid following the transition to the next curve cycle (see chapter "15.3.2 Label synchronization").

14.2 Label set point (M_M /S_M):

Master or slave position within the curve on which the label, i.e. the rising edge is reset at I14. This adjustment is made by entering positive or negative correction pulses into the integrator for the master position or to the slave set point. The evaluation of I14 occurs in 100µs cycles. (This results in an error of 0.18 degree in the edge measurements at a master rotation speed of 300 min^{-1} and a master cycle of 360 degree). The label set point can lie in the whole value range from 0 to the master or slave cycle S_T.
The label set point is used to produce the label reference as a processing point in the curve.
COMPAX uses this to calculate an internal label set point M_{ref} or S_{ref}.

Internal calculations with master related label synchronization:

$M_{ref} = M_M - |P32|$,
Master cycles are added until the result lies in the value range 0...M_T .

Internal calculations with slave related label synchronization:

$S_{ref} = S_M - |P32|$,
Slave cycles are added until the result lies in the value range 0...S_T .

M_{ref} or S_{ref} is the actual reference between label signal and processing point and is shown as Status S50 in ‰ of the relevant cycle.

14.3 Label window (M_f):

The label window is positioned symmetrically around the internal label set point M_{ref} (Status S50) (M_f= half window width). Only a rising edge in I14 within this window will lead to a calculation of a correction value. If the activated synchronization does not detect an edge, this is indicated by O14="0". O14 is reset to "1" when the next window is reached.

Restriction: $M_f \leq 0{,}3 * M_T$

M_f is typically 10% of the master or slave cycle.

The first measurement of the label after

- synchronization is enabled after "Power on"

or

- the operation mode is enabled with P33

is implemented without the label window.
The first correction takes the label from each starting position in the vicinity of the set point.

Attention!

If I14 goes to "1" before the window and remains at "1" at the beginning of the window, a rising edge is recognised at the window start and this point will be interpreted as the label value.
If I14 remains on "1", a label signal is recognised cyclically at the window start. The resulting corrections lead to a drift in the positive master direction of M_f per cycle.

14.4 Enable correction(M_{k1}), Disable correction (M_{k2}):

With "Enable correction", the correction of the master or slave position can begin.
With "Disable correction", the correction must be interrupted or terminated. Both positions can lie in the region 0 to master cycle (they are always derived from the master channel). When the corrections are allocated, it is ensured that the corrections are terminated in the next label window. If M_{k1} > M_{k2}, corrections are implemented past the cycle.
When processing the product in the synchronous range, the corrections can be disabled with M_{k1} and M_{k2} .

14.5 Status

Status: S50: internal label set point M_{ref} in ‰ of the relevant cycle
S51 Label value in ‰ of the cycle.
S52: Label correction in ‰ of the cycle.

Digital output O14 = "0": Label missing.
After Power on, O14 is initially at 0. At the first label, O14 is set to "1" and is then valid from this point in time.

14.6 Label synchronization with correction limitation

Label synchronization with limitation of label correction.
P180 denotes whether a limitation of label correction should occur or how large the permissible correction - based on the appropriate cycle - should be. Status 52 again shows the unlimited errors.

Definitions:

Initial correction
The initial correction is the first correction at the start of label synchronization.

Start-up correction
The start-up correction consists of the initial correction and as many additional corrections are required to bring the label into the label window. The start-up correction is terminated from the point in time where the label first lies within the window. Additional corrections will only be implemented after this when the label lies within the label window.

Parameter P180
The unit for P180 is %.

|P180|	Correction
◆ =0 (Reset status in the ParameterEditor) ◆ or =100 (Reset status of COMPAX after RESETP) ◆ or >100	Initial correction unlimited Follow-up corrections are then only implemented when the label lies within the label window after the initial correction
<= Label window	Start-up correction limited to P180/100*(M_T or S_T) Follow-up correction also limited by P180 **Example:** Correction value = 40% MF = 20% and P180 = 10% 10% corrections are carried out in each of 4 cycles.
> Label window	Start-up correction limited to P180/100*(M_T or S_T) Follow-up corrections not limited by P180, as they are limited by M_F . **Example:** Correction value = 40% MF = 20% and P180 = 30% In the 1st cycle 30% is corrected, in the 2nd cycle 10%..

14.6.1 Master or slave related

Remark:

- **The master related label synchronization operates from the time when the master position measurement is enabled.**
- **The slave related label synchronization operates from the synchronous operation (O16="1"). This is switched off during decoupling.**

Parameter

P33="0": Without label synchronization.

P33="1": Master related label synchronization. The label sensor is located in the master channel.

P33="2": Slave related label synchronization. The label sensor is located in the slave channel.

P33 acceptance

Any modification of P32 (and P33) becomes valid following the transfer to the next curve cycle (see chapter "15.3.2 Label synchronization").

P33="1": Master related label synchronization.

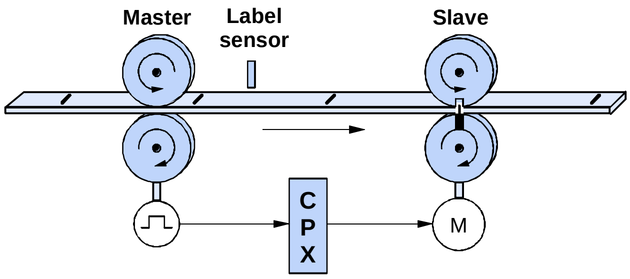
Mode of operation:

The master transports the product; the slave processes the product.

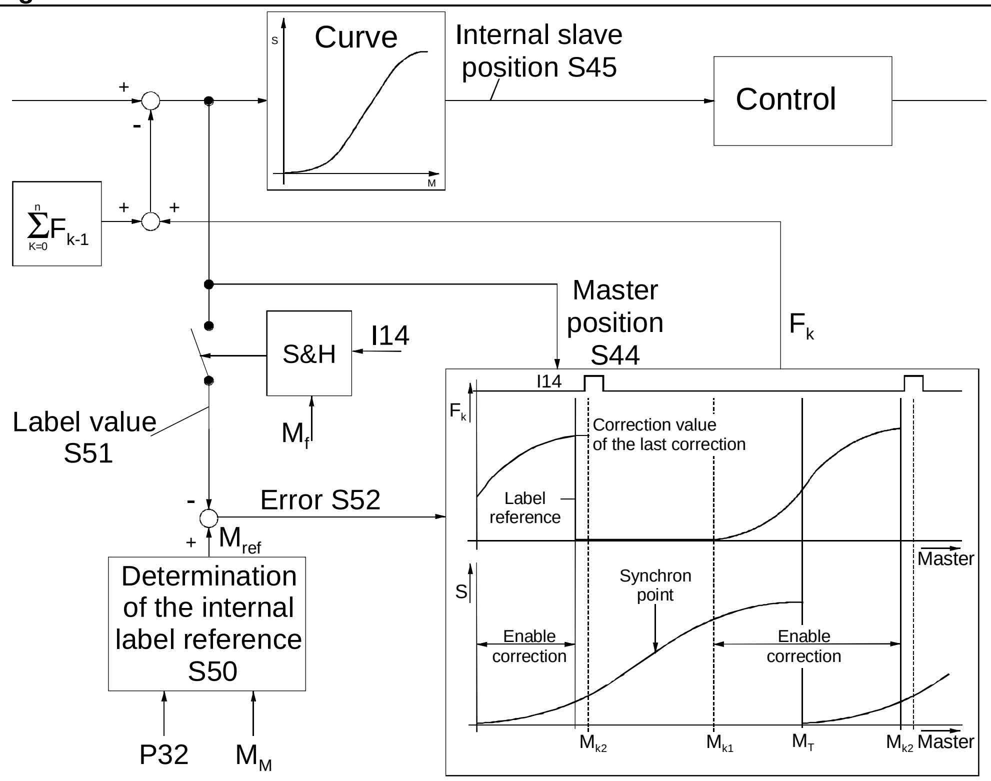
If there are differences in the master channel between product speed and master speed (e.g. through slip), corrections are implemented in the master channel (before the curve) using the correction value determined by the label sensor.

Example: Cutting plastic bags:

Master transports product, slave operates blade.



Structure diagram:



F_K: Determined correction	**M_T:** Master cycle	**M_{ref}:** Internal label set point
M_f: Label window	**M_{k1}:** Enable correction	**P32:** Distance of label sensor
M_M: Label set point	**M_{k2}:** Disable correction	**I14:** Label input

ΣF_{k-1}: Sum of all previous corrections since label synchronization activation

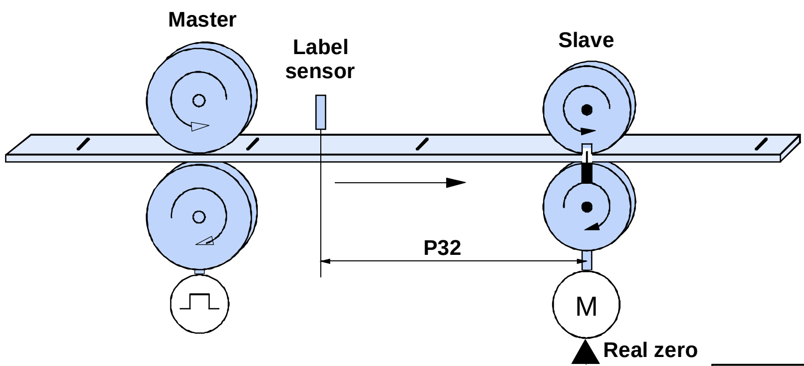
Setting the master related label synchronization

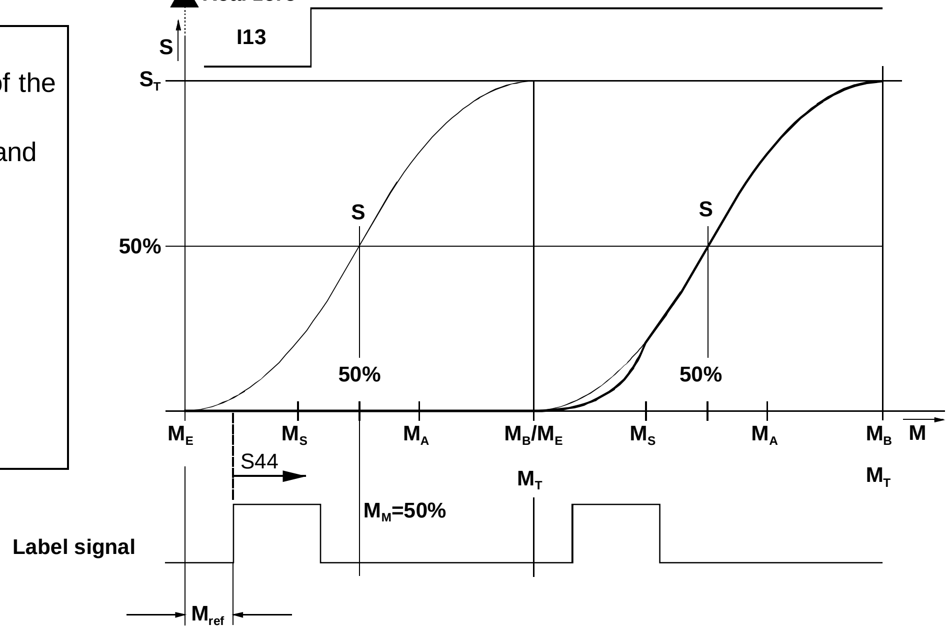
Before starting cam operation with LOOP and I13="1", a reference between the curve and the mechanics must be set up.
Procedure with unit stopped:

- Curve start point defined as slave real zero.
- Label signal connected to I14 and I16.
  The master position measurement then starts simultaneously with the label signal.
- Set P31 = "2".
- Select required curve with "SETC n".
- Move slave using "POSA 0" to real zero.
  Set the start position of the master position measurement to the internal label set point Mref; the master position measurement starts at this position (due to the label signal being connected to I16). This is implemented with the command:
  "SETM x" with $x = \frac{S50}{10} = M_{ref}$ ("/10" because x is given in % and S50 in ‰)
  Once I16="1" is recognised, S44 also begins to operate from the value in S50.

Attention: S50 changes with P32 and with the selected curve; S50 must therefore be read out after each change.
If the master position is not aligned with "SETM S50/10", a larger correction movement may be necessary in the 1. cycle.

- Activate the "LOOP n" command and enable the coupling procedure with "I13="1".
- The unit can now be started:
  The master position measurement is enabled with the next label. The master position measurement starts from the correct value due to the preset starting value.
  The slave is activated by I13="1" and LOOP and starts the coupling procedure at the next coupling position M_E, it is then sychronous with the curve from the synchronous position M_S.

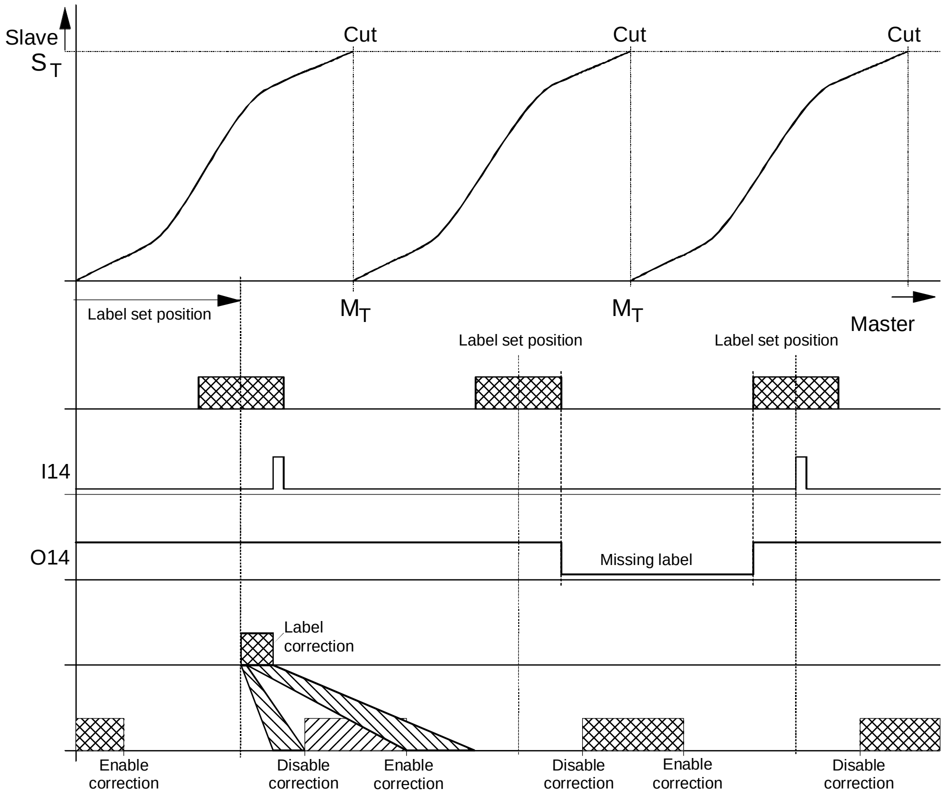




Summarised procedure:

- Curve start point = Real zero of the slave.
- Label signal connected to I14 and I16.
- P31 = "2"
- "SETC n"
- "POSA 0"
- "SETM x" with $x = \frac{S50}{10} = M_{ref}$
- "LOOP n" and "I13="1"
- Start the unit

Example 1: Master related label synchronization



P33="2": Slave related label synchronization.

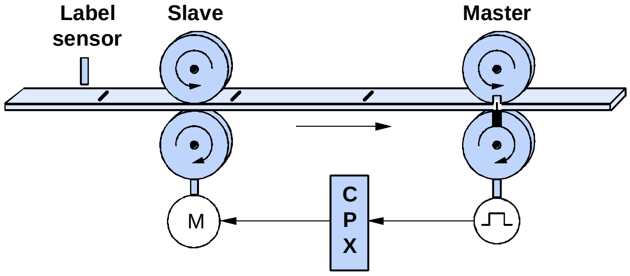
Mode of operation:

The slave transports the product; the master processes the product.

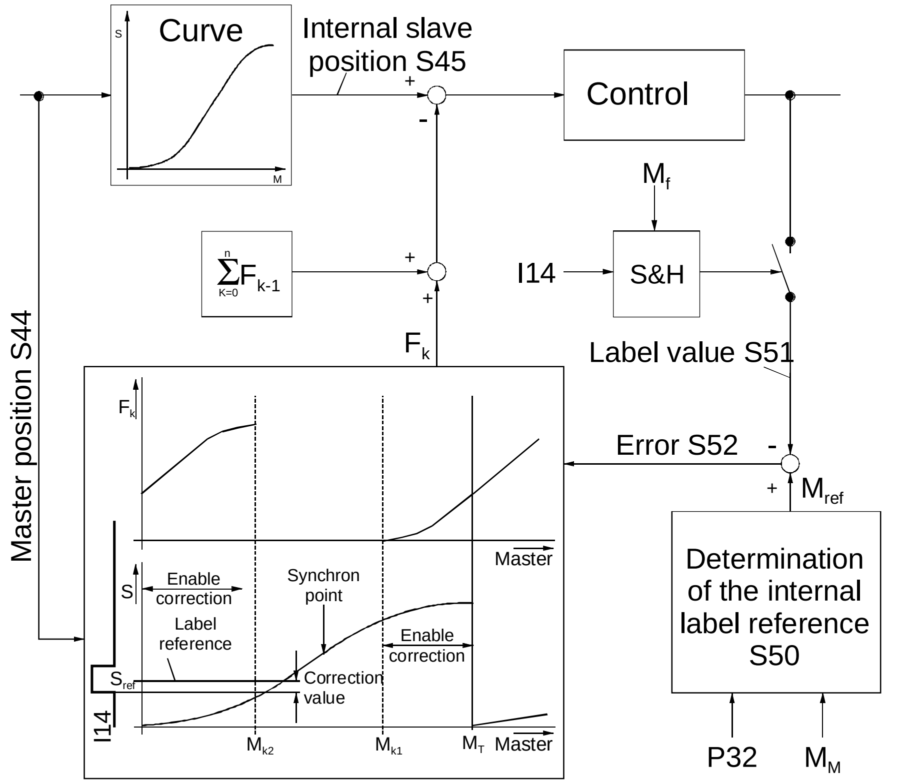
If there are differences between the slave speed and product speed (e.g. through slip), corrections are implemented in the slave channel (after the curve) using the correction value determined by the label sensor. I.e. the slave modifies its speed in order to compensate for the slip.

Example: Cutting paper band:

Cutting paper band: Master operates blade with constant speed; slave feeds paper in



Structure diagram:



F_K: Determined correction value	**M_T:** Master cycle	**M_{ref}:** Internal label set point
M_f: Label window	**M_{k1}:** Enable correction	**P32:** Distance of label sensor
M_M: Label set point	**M_{k2}:** Disable correction	**I14:** Label input

Advice

The slave related label synchronization is only applicable with a rising slave position.

Unless otherwise indicated, implement a rotation direction change by modifying P215 and not by modifying the value sign in the set point table.

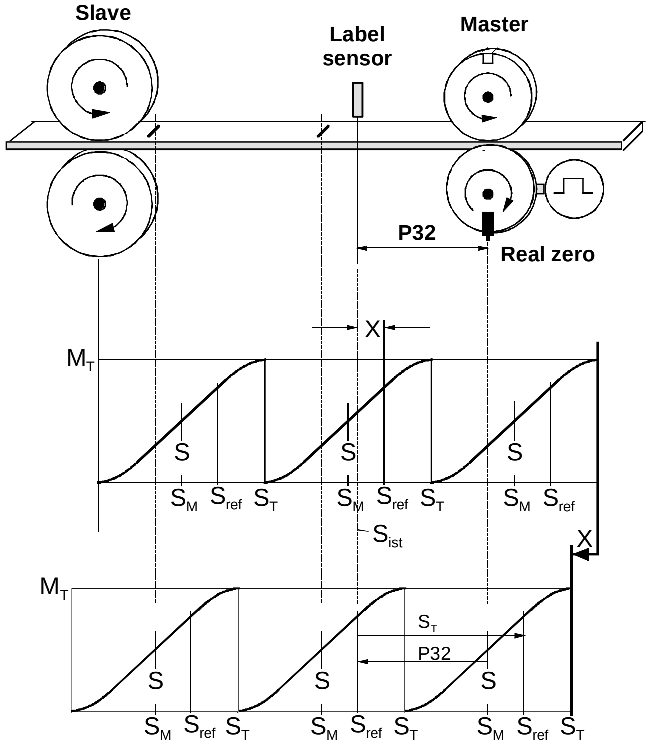
The master must also rise constantly (S44 rising).

Setting the slave related label synchronization

Before starting cam operation with LOOP and I13="1", a reference between the curve and the mechanics must be set up.
I.e. a curve position must be allocated to the slave position and master position.
Procedure with unit stopped:

- Reference point of master defined as the curve start point; set real zero=0.
  This takes place when constructing the curve, as the master position 0 of the curve is set with the reference point.
- Connect the reference signal of the master with I16.
  The master position measurement then starts simultaneously with the reference signal.
- Set P31 = "2".
- Select required curve with "SETC n".
  The curve must not be selected beforehand, otherwise the master position measurement will start operating during the master reference run (after the pulse to I16).
- Enter SETM 0; set defined master position to 0.
  This is important if the master position measurement was already operating during the master reference run (after the pulse to I16).
  The slave still has no reference to the curve.
- Activate the "LOOP n" command and enable the coupling procedure with I13="1".
- The unit can now be started:
  The slave position is determined with the next label and, without taking into account the label window, the S_{ref} error is determined.
  The resulting correction value can be very large as the slave reference is missing.
  COMPAX implements this correction in the following curve cycle and this results in the correct slave reference being set.
  The next label will only be recognised in the label window.

Graphic representation:



Calculation of S_{ref}: $S_{ref} = (S_M - P32) + S_T$

S: Processing point (Synchronous point)
X: Correction value with which the slave must be corrected.

At the start, the current slave position is assumed to be 0. With reference to the label, this value is generally incorrect. The correction value is determined after the first label signal: $X=S_{act} - S_{ref}$

Summarised procedure:

- Reference point of master = Curve start point.
- Connect the reference signal to I16.
- P31 = "4"
- "SETC n"
- "SETM 0"
- "LOOP n" and "I13="1"
- Start the unit

15 Dynamic curve transfer by linking "curves"

15.1 Requirements

To use the function "Curve linking", the operation mode "Parallel mode" is necessary (P210="1").

P210="0": linear processing of the program memory (previous settings)

P210="1": Parallel mode;
the program continues to run during positioning commands and stops at the next positioning command.
When commands are set by bus, it is the second positioning command that is rejected.

Attention! Parallel mode does not only relate to curve commands!
Switch off the parallel mode for normal movement programs.

Any modifications to P210 are effective immediately (without VP).

Coupling/decoupling function P34="4":

- Decoupling independent of coupling parameters and independent of I13 at the end of the current master cycle, unless the loop counter has stopped.
  This function is necessary for an instantaneous curve transfer.
- Coupling/decoupling movements using coupling parameters triggered by the input I13 are not possible if combined with the "Curve linking" function! Set the coupling parameter to 0 (default setting of the CamEditor).
- Coupling mode using P34=0 and MB=MS=0 is possible as described on page 25.
- Define the coupling/decoupling movements by using special curves.

The function "Curve linking" is possible using the existing commands.

15.2 Implementing the function "Curve linking"

- The first curve is selected with the first SETC command.
- The curves are aligned as before using the commands SETM, SETS or POSR CAM.
- Using the command LOOP n, the 1st curve is processed n times.
  During this operation the 2nd curve can be selected using SETC x and LOOP n; the 2nd curve then starts instantaneously after the 1st curve is terminated.

⇨ A processing time of ca. 10ms is required for the interpretation of the commands in the program memory (or when received via interface); i.e. the curve must have already been selected using SETC and LOOP, ca. 10ms before the start of the next curve.

Note regarding reverse travelling of individual curves

The data memory only operates forwards, while individual curves can also be travelled in reverse. However, once the curve start has been reached, the previous curves are not activated or processed.

Program example 1: Curves in the normal mode: Curve 1: Start position 1 to doffing position 1
Curve 2: Doffing position 1 to start position 2
Curve 3: Start position 2 to doffing position 2
Curve 4: Doffing position 2 to start position 1

P210=1	Switch on parallel mode
SETC 1	Select first curve location 1 -> doffing 1
SETM x	Align master
SETS	Align slave
LOOP 1	
If I8=....	selection of 2nd curve possible based on external conditions
....	
SETC 2	Doffing position 1 to start position 2
LOOP 1	
If I7=...	selection of next curve possible based on external conditions
....	
SETC 3	Start 2 -> doffing 2
LOOP 1	
If I8=...	selection of next curve possible based on external conditions
....	
SETC 4	Doffing position 2 to start position 1
LOOP 1	
...	

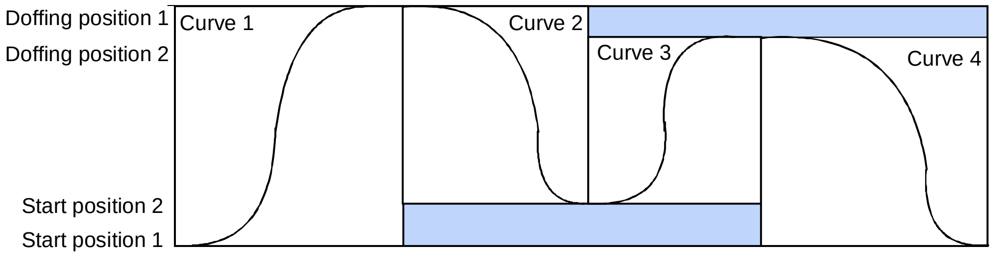


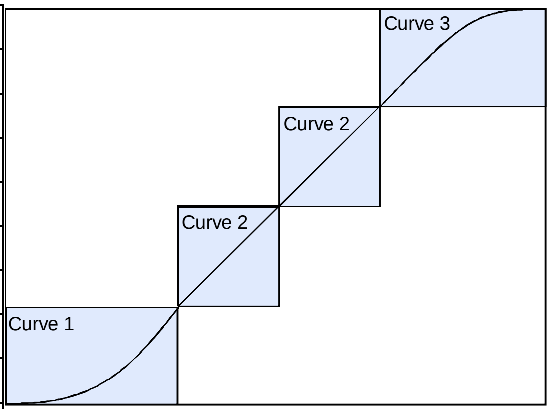
Figure: Linked curves with same start and end gradient

In this example, several curves which all have standstill phases at the end are linked together.

Program example 2: Multiple travelling of open curves

It is also possible to compile a motion profile from several curve segments which do not have acceleration or speed zero at the curve borders.

N001:	P210=1	Parallel mode
N002:	SETC 1	Select 1st curve
N003:	SETM x	Align master
N004:	SETS	Align slave
N006:	LOOP 1	Execute 1st curve
N007:	SETC 2	Select 2nd curve
N008:	LOOP 2	Execute 2nd curve
N009:	SETC 3	Select 3rd curve
N010:	LOOP 1	Execute 3rd curve
N011:	SETC 1	Select 1st curve
N012:	GOTO 6	return to processing the 1st curve



Linked curves with different start and end gradients

Note that curves with different start and end gradients cannot be compiled with the current CamEditor version!

Variable "Curve linking"

Only curves with a pre-defined number of cycles can be linked, as linking can only occur in connection with a terminated LOOP counter.

- The variable LOOP 0 cannot be used in this case.
- Linking with a falling edge on I13 is not supported.

Implementation:

If a variable number of cycles are to be travelled, this must be implemented using an external counter in the program memory or the higher-level controller.
Example:

N001:	P210=1	Parallel mode
N002:	SETC 1	
N003:	SETM x	
N004:	SETS	
N006:	LOOP 1	
N007:	If I8=1 GOTO 6	Curve 1 is repeated until I8=0
N008:	....	
N009:	SETC 2	
N010:	LOOP 1	

15.3 Conditions

15.3.1 Master position measurement P31

At P31 = 2 or 4: The master signals can only be disabled with SETC n, when n linked curves have been processed!

15.3.2 Label synchronization

- Label synchronization with linked curves can only be implemented within a cyclical curve (or within a curve segment of the whole curve).
  In other curves (curve segments) the label synchronization must be switched off, as there is no label signal available and this would produce the error message "Label missing" (O14).
- The parameter for the selection of the label synchronization operation mode (P33) is accepted with VP. So that label synchronization for a particular curve segment can be enabled, **P33 must be accepted when triggered by the start of a curve** .
  By introducing an additional identifier in P33 (10th position), P33 is accepted at the end of a master cycle (at the time of the reset pulse).
  This makes it possible to switch between master and slave related label synchronization with the same curve during operation, if drift is present on both channels.
- Note that with every switch, due to construction constraints, another P32 is probably required. To avoid data inconsistency, a triggered acceptance of P32 is possible (after VP).
  Note also that the correction of a label error in the current cycle is normally implemented in the next cycle.

Overview: Operation modes for label synchronization in "Curve linking"

P33		Valid with VP and
	=0...2	Acceptance triggered with LOOP
	=10...12	Acceptance triggered with 1st LOOP command or at the end of the current cycle. The single digit indicates the label synchronization operation mode.
P32		Valid with VP and Acceptance triggered with LOOP or at the end of the current cycle.

15.3.3 Curves

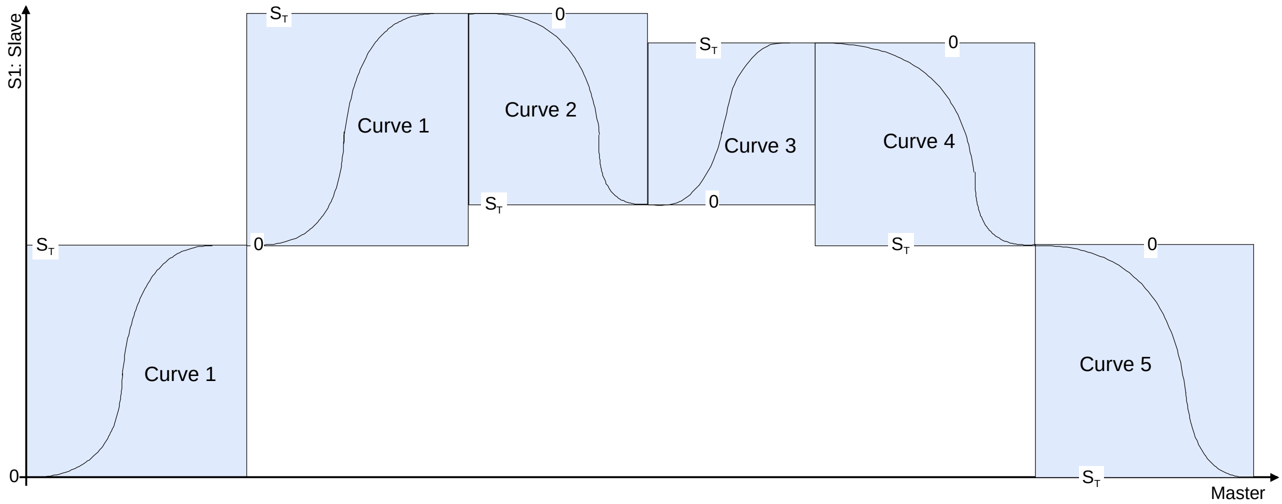
The distance between the fixed points in the various curve segments is interpreted in dependence on the selected master cycle. The number of curve set points can differ.
The parameter P98 is a VC parameter and can't be changed during cam operations.
The following conditions must be met for the transfer between curves:

- The gradients on the end of a curve and on the start of the next curve must coincide; otherwise jumps in speed occur.
- The weighting of a master increment with reference to the slave increment must be constant during the curve transfer. Otherwise, a jump in speed occurs.
- For a whole curve with curve transfers with a gradient ≠ 0 (as in example 2), that is expanded or compressed in the format, the condition P35 * P36 = const. must be maintained; otherwise jumps in speed occur at the transfers.

15.3.4 Operation modes

Normal mode

- In the curve transfer, the zero point of the next curve is set to the last curve point of the last curve; a curve alignment occurs.
  The absolute reference is maintained while in normal mode.
- **Attention!** In curves that do not begin at 0 (e.g. first curve value is at 60°), COMPAX receives a set point jump when switching to these curves; i.e. the transfer is not smooth!
- **Example:** Curve linking in normal mode



  Curve 1 is travelled 2 times; at the start of curve 2 an alignment is implemented, so that the curve value 0 of curve 2 starts from the end value of curve 1. The same applies for the transfer to curves 3 and 4.
- Compiling curves:
  Value range of the slave within the curve:
  - Curve 1 from 0 ... 360°; (travelled 2 times)
  - Curve 2 from 0 ... -300°;
  - Curve 3 from 0 ... 260°;
  - Curve 4 from 0 ... -320°;
  - Curve 5 from 0 ... -360°;

Reset mode

- In the reset mode (P93=3), the motion behaviour is comparable to that in normal mode, but with modified value ranges for the actual value (S1). The actual value is back-calculated after each curve cycle to S_T of the last curve cycle.
  This also applies where a cycle is only partially travelled due to SETM ≠ 0 (without SETS or POSR CAM).

16 Internal time base

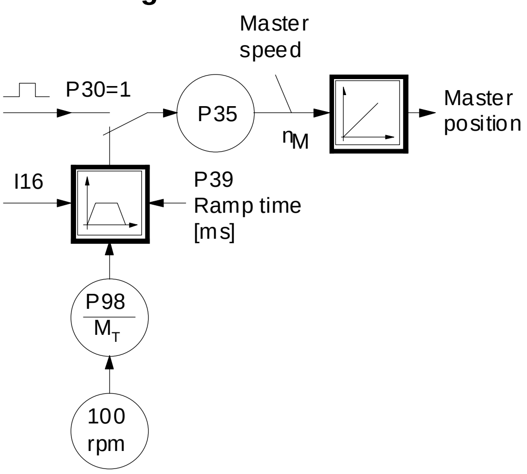
COMPAX 70 can be operated without being coupled to a master. An internal time base simulates the master rotation speed.
The switch located in the slave input channel is set with parameter P30:

- **P30="0":** The master rotation speed is read by the encoder input channel.
- **P30="1":** The master rotation speed is simulated in the slave.
  Where:

  $$\text{Master rotation speed} = \frac{100\,\text{min}^{-1} \bullet P35 \bullet P98}{M_T}$$

  This is approached after enabling (e.g. with I16) with the ramp time P39.
  P39 is an absolute time; depending on the target speed, the gradient used to approach this time varies.

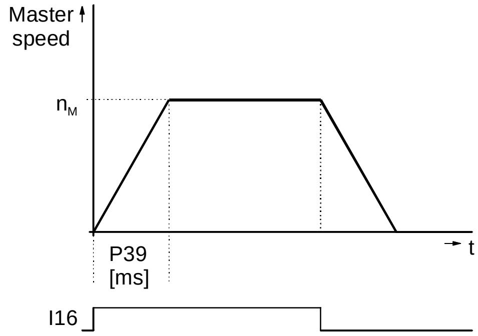
Structure diagram:



The ramp time (P39) is only activated when I16 is enabled.

Attention!	
⚠	Any modification of the factors (P98 and M_T) occurs with a jump! Jump-free switching of the simulated master rotation speed is only possible using P35 and P179 (See page 46). The relevant parameters must only be modified in small steps.

Speed profile after enabling with I16



Note

With P98 = M_T and P35=1, the master cycle is travelled 100 times in 1 minute (with P35=2, 200 times per minute).
In general:

$$n_{internal} = 100\text{min}^{-1} \bullet \frac{P98}{M_T} \bullet P35$$

With M_T = 100 • P98, the cycle rate per minute can be set directly in P35 (take into account the permissible value range: see page 9).

Jump-free switching between master channel and internal time base

To achieve this, the internal set point must coincide with the external set point of the switching time.
P35 must be adapted for this purpose:

$$P35_{new} = \frac{P35_{old} \bullet V_{ext}}{P98}$$

using: $P35_{old}$: previously set value
$P35_{new}$: value to align the internal setpoint
V_{ext}: externally determined master speed
P98: Master travel per encoder revolution

Set P39 to 0 and ensure that the master position measurement is enabled before switching, so that the ramp time is already terminated.

17 Triggered Transfer of P35

P30:	Action:
0...9	P35 always transferred
10...19	P35 only transferred at curve end, i.e. when the master cycle is reached

Triggered transfer is only done in synchronous mode, i.e. with O16=1. Otherwise P35 is always transferred immediately. Following the triggered transfer is - if so parameterized - the ramp adjustment of P35.

18 Ramp Adjustment of P35

Changing P35 is basically done by considering the ramp time P179. Specifically, the reciprocal of P179 is interpreted as change per ms.
If a jump-type change is indicated by P35, the effective factor is adjusted by 1/P179 until the new value of P35 is reached. This makes the slope constant regardless of the magnitude of change of P35.

Definition P179:

P179 displays how many ms it takes for P35 to alter by 1.0.

Range:

The limits of P179 are
at 0 (or 1): for a jump-like adjustment of P35 or

at 2^{23} for a change of P35 by 1.0 in ca. 5.8 hours.

Accuracy

The accuracy of the ramp is inversely proportional to P179. The time error during the processing of the ramp is approximately calculated by
$F < 100\% * 2^{-23} * P179$.
Example: P179 = 1000ms --> F < 0.012%

19 Special Inputs and Outputs

19.1 Function of Inputs

Enabling of Power Output Stage	I12	

- I12,
  - during a positioning process
  - during a program is running, i.e. also when the LOOP command is active

is not evaluated.
- By I12="1" the power output stage is enabled.
- By I12="0" the power output stage is disabled.

Decoupling / Coupling	I13	

I13 is only of importance during cam operation
- I13="0": decoupling
  After a signal change at I13 from "1" to "0", the slave decouples in accordance with the preset decoupling mode and travels to the standstill position.
- I13="1": coupling
  After I13 having been given a signal to change from "0" to "1" the slave will couple according to the adjusted coupling mode.

Label input	I14	

The label input I14 is only recognized, when the online label synchronization is switched on using P33≠0.
- The label can be perceived by a positive edge of I14.
- I14 is polled by COMPAX at a cycle of 100µs.

⇨ The label impulse has to be longer than 100µs.

Enabling/Disabling of the Auxiliary Functions	I15	

- I15="1": the auxiliary functions are enabled.
  During cam operation the outputs O7 to O14 are influenced by the auxiliary functions of the resp. last curve set point exception the outputs, which are disabled by P38 (masking)
- I15="0": the auxiliary functions are disabled.
  After "LOOP" the outputs O7 to O14 remain at the reset value indicated by P37.

⇨ The analogue auxiliary functions are always prepared independently from I15!

Enabling/Disabling of the master	I16	

By I16 you can enable or disable the master signals.

Attention!

⇨ Before enabling the master position counting you must have selected a curve by SETC n.

By P30 and P31 different adjustments are possible.

Survey:

P30="0"	P30="1"
P144="4" The rotational speed is read by means of an encoder channel.	The rotational speed is simulated internally.

Enabling / Disabling of the Master by I16 **Adjustable by P31**					
At P30="0" and P144="4" (master signals via encoder)					
	Function		**Operation mode possible when operating with:**		
P31	**Enabling of master**	**Disabling of master**	**E2 / E4**	**HEDA**	**Parallel mode**
="0"	I16="1" statical evaluation	I16="0" statical evaluation	✓	✓	✓
="1"	I16="1" "rounded off" with encoder zero pulse.	I16="0" statical evaluation	✓	Zero pulse missing!	✓
="2"	After curve selection (SETC n) by a positive edge of I16.	By a further curve selection with SETC n and I16="0". With I16="1", the master position measurement continues to operate!	✓	✓	Restricted[3]
="3"	After curve selection (SETC n) by a positive edge of I16.	Automatically after one master cycle, but not when I16="1".	✓	✓	✓
="4"	After curve selection (SETC n) by a positive edge of I16.	By a further curve selection with SETC n, independently from I16.	✓	✓	Restricted
="5"	After curve selection (SETC n) by a positive edge of I16.	Automatically after one master cycle, independently from I16.	✓	✓	✓
="9"	I16="1" Statical evaluation (for HEDA coupling).	I16="0" statical evaluation	✓	✓	✓

I16 can be perceived by means of "interrupt".

Operation mode P31="2" is handled during operation with internal time base (P30="1") like P31="0".

Description:

Condition:

- Connected with the master by means of an encoder (E2 or E4), which is switched to the encoder input of COMPAX XX70, or
- Coupling via HEDA.
  (see User Guide COMPAX-M/S)

At this operation mode you can choose by P31 the type of signal which allows to enable the master position.

P31="0": Statical enabling of master signals by I16.

I16="0": Disabling of master signals.

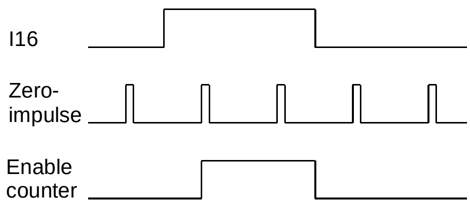
I16="1": Counting master signals.
By I16 "1" the increments of the master signals can exactly be counted without any time lag.
After "Power On" I16 must be "0" so as to be able to perceive the ascending edge.

P31="1": Statical enabling of master signals by I16; edge-triggered by the encoder zero pulse. (Not possible with HEDA coupling as the zero pulse is not present).

I16="0": Disabling of master signals and encoder zero impulse.

I16="1": Enabling of encoder zero impulse.
With I16="1", the master signals are taken into account incrementally without time delay from the next encoder zero pulse.
This means that you may indicate a defined start refering to the rotor position of the motor.

[3] The master signals can only be disabled with SETC n, when there is no active positioning command!



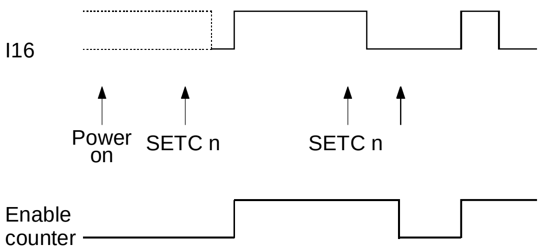
P31="2": Enabling of Master Signals, edge-triggered by by I16.

I16="0": The encoder signals would be considered, if a positive edge of I16 preceded and if since that moment the curve was not changed (by SETC n).
The encoder signals are not taken into account when, although a positive edge has occured at I16, the curve has been changed (using SETC n) since that time.

I16= "1": The encoder signals are taken into consideration. The master position which has been determined in the slave, now changes according to the impulses counted at the encoder input.

Actuation of Master Position counting by P30="0" and P31="2".

Function:	Generated by...
Enabling of master	**SETC n and then a positive edge at I16**
Disabling of master	**SETC n and I16="0"**



- After "Power On" the input I16 will only be considered after the first "SETC".
- By another "SETC" the counter is disabled.
- The counter will only be enabled if (after the command SETC) input I16 disposes of an ascending edge!

P31="3": Enabling of Master Signals, edge-triggered by I16 for one Master Cycle.

I16="0": The encoder signals would be considered if a positive edge of I16 preceded and if since that moment the curve was not changed (by SETC n).
The encoder signals would not be taken into consideration if a master cycle was travelled.

I16= "1": The encoder signals are taken into consideration. The master position which has been determined in the slave, now changes according to the impulses counted at the encoder input. After having finished the master cycle, master-position counting will again be disabled.
(also see page 23)

Actuation of Master Position Enabling by P31="3"

Function:	Generated by...
Enabling of master	**SETC n and then a positive edge at I16**
Disabling of master	**After one master cycle and I16="0"**

If I16 is still "1" at the end of the master cycle, automatic triggering occurs.

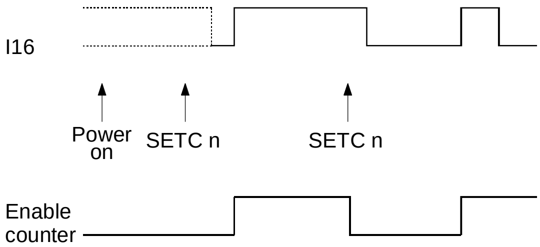
P31="4": Master signal enabled, edge triggered via I16.

I16="0": The encoder signals are taken into account when a positive edge has occured at I16 and no curve change has been made since this time (using SETC n).
The encoder signals are not taken into account when, although a positive edge has occured at I16, the curve has been changed (using SETC n) since that time.

I16=Edge from "0" to "1": The encoder signals are taken into account. The master position which has been determined in the slave, now changes according to the impulses counted at the encoder input.

Actuation of Master Position Enabling by P31="4"

Function:	Generated by...
Enabling of master	**SETC n and then a positive edge at I16**
Disabling of master	**SETC n independent from I16**



- After "Power On", the input I16 will only be taken into account after the first "SETC".
- By another "SETC" the counter is disabled.
- The counter will only be enabled if (after the command SETC) input I16 disposes of an ascending edge!

P31="5": Master signal enabled, edge-triggered via I16 for a master cycle.

I16="0": The encoder signals are taken into account when a positive edge has occured at I16 and if the curve has not been changed since this time (using SETC n) or has not been completed. The encoder signals would not be taken into consideration if a master cycle was travelled.

I16=Edge from "0" to "1": The encoder signals are taken into account. The master position which has been determined in the slave, now changes according to the impulses counted at the encoder input. After having finished the master cycle, master-position counting will again be disabled. (See also page 23)

Actuation of Master Position Enabling by P31="5"

Function:	Generated by...
Enabling of master	**SETC n and then a positive edge at I16**
Disabling of master	**After a master cycle**

In general the following applies: If no curve has been selected since "Power on", I16 is not taken into account.

P31="9": Master signals enabled, statical via I16 (for HEDA operation).

I16="0": Disabling of master signals.

I16="1": Counting master signals.
The master signals are taken into account with I16="1" in the next sampling cycle.
(Increment precise acknowledgement is not required as the process value is only updated in 1ms cycles).

19.2 Function of Outputs

Label Error	O14	(low active)

- O14 only has the significance " Label missing" during online label synchronization, apart from this O14 is available as an auxiliary function.
- O14="1": label within the label window.
- O14="0": no label within the label window.
  O14 will be set to "0", if there is a label missing, after the label window and remains at "0" until the next label is recognised.

Tracking Warning	O15	(low active)

By O15="0" there can be signaled that the tracking error exceeds P79.
- O15="1": the tracking error is smaller than the tracking zone given by P79.
- O15="0": The tracking error is larger than the tracking zone given by P79.
- The output O15 is actualized at each movement.

Synchronous Operation	O16

- O16="0": The slave does not follow the indicated curve.
- O16="1": Synchronous operation; according to the curve the slave moves synchronously to the master.

20 Special Status Assignment

S2:	During cam operation S2 indicates the total number of curve travels (m).
S41:	Master rotation speed in min^{-1}.
S42:	Master position indicated in increments of encoder module (increments will be reset when there is an overflow). 4 x evaluation; value range ±8 000 000
S43:	Number of activated curve
S44:	Master position in ‰ of the master cycle.
S45:	Internal slave set position of the curve in ‰ of the slave cycle.
S46:	Sign of master speed. "0": positive; "1": negative.
S47:	Slave set position from set point interpolation in units.
S48:	Loop counter (LOOP m); counts downward from "m" to "0". At a cyclical travel with "LOOP 0" S48 = -8388608.
S49:	Physical position target for POSR
S50:	Internal label set position M_{ref} in ‰ of the corresponding cycle.
S51:	Internal actual value of the label in ‰ of the corresponding cycle.
S52:	Label correction in ‰ of the corresponding cycle.

Format of the status values: 8 digits in front of the comma, 3 digits behind the comma

The status indications from S41 can be carried out by the front panel display of COMPAX XX70. If there is an overflow 3 strokes will appear.

Note

By S44, (at slave-related label synchronization by S45), S50, S51 as well as by S52 the label counting can be checked. If there is a label signal, S44 respectively S45 will be written into S51. The difference to S50 represents the correction value S52.

21 Optimizing indicators via S13 and S14

Optimizing indicators for COMPAX XX70
(P233->S13, P234->S14):

Function Pointer Marker Synchronization

P233/P234=31: "Function pointer marker synchronizaton"
This function pointer indicates the conditions of the marker synchronization. P233=31 outputs the function pointer on S13.

Normalized Correction Factor

P233/P234=32: "normalized correction factor"
The status "normalized correction factor" runs during marker correction from 0 to 1000 per mil. P233=32 outputs the normalized correction factor on S13.

Cycle Counter

P233/P234=33: "Cycle Counter"
The cycle counter starts at 0 at the beginning of curve processing (i.e. already at the coupling stage) at the moment the LOOP command is processed and counts the passages of the master position through the master timer sequence (1 = 1 passage). The counter has a range of 2^{23} master counter sequences with a resolution of 7 decimal places. Counting is stopped by exiting curve mode at the end of an uncoupling move. The value remains constant until the LOOP command is processed again. The status is therefore re-set at the next curve processing.
As long as curve mode is active, i.e. when changing from uncoupling to the wait position for coupling, the cycle counter remains active. If it is output to the DA monitor, only the place in front of the decimal point can be displayed.

Encoder frequency channel 4

P233/P234=37: "encoder frequency channel 4"
The status "encoder frequency channel 4 in incr./ms"

22 Special error messages

E17: Curve not present.
Previous meaning, "Selected set number not present", is retained.

⇨ After E25 or E65, HEDA coupling can only be enabled again with a status change at I16 (I16="0" / I16="1").

23 Cam controller parameters

No.	Meaning	Unit	Minimum value	Default value	Maximum value	Valid from
Cam parameters						
P30	Select master input	="**0**": Coupled to master by means of an encoder ="1": Not coupled to a master; simulation of master speed by an internal time base ≥10: The tens digit indicates whether P35 is accepted when master cycle is reached				VP
P31	Operation mode I16 "enabling of master position" (label-related starting of counter). Should there be used the internal time base (P30="1") the operation mode P31="2" would be treated like P31="0".	="**0**": Statical enabling of master signals by I16. ="1": Statical enabling of master signal by I16 and edge-triggered with the encoder zero impulse.[4] ="2": Enabling of master signals edge-triggered by I16. Disabling with SETC n and I16="0". ="3": Enabling of master signals, edge-triggered by I16 for one master cycle only. Disabling by I16="0" at the end of the master cycle (when I16="1" triggering occurs). ="4": Master signal enabled, edge-triggered via I16 for a master cycle. Disabled by SETC n. ="5": Master signal enabled, edge-triggered via I16 for one master cycle only. ="9": Statical master position enabling by I16 for HEDA coupling. HEDA coupling is also possible with P31="0".				VP
P32	Distance of label sensor	Unit of corresponding cycle	0.000000	**0.000000**	$10 \cdot M_T$ $10 \cdot S_T$	VP & at the end of the current curve cycle
P33	Operation mode of label synchronization	="**0**": No label synchronization ="1": Master-related label synchronization ="2": Slave-related label synchronization				VP & next curve
		="11": Master related label synchronization; ="12": Slave-related label synchronization				VP & at the end of the current curve cycle
P34	Coupling mode (**Note:** M_S and M_B are taken into account independently from P34; if this is not required, set $M_S = M_B = 0$; see also from page 24)	="0": Without coupling and decoupling positions (Bit 0="0"). ="**1**": With coupling and decoupling positions (Bit 0="1"). ="2": Leave cam operation after decoupling (Bit 1="1") ="4": Leave curve when loop counter terminates (LOOP n) at the end of the master cycle (Bit 2="1"). The settings can be combined; the sum is then entered in P34.				VP & SETC
P35	Factor in the master input channel		-1000.000000	**1.000000**	1000.000000	VP
P36	Scaling factor		-1000.000000	**1.000000**	1000.000000	VP and see[5]
P37	Reset value for digital auxiliary functions (Standard: **00000000**)	O7 = 2^6, O8 = 2^7, O9 = 2^8, O10 = 2^9, O11 = 2^{10}, O12 = 2^{11}, O13 = 2^{12}, O14 = 2^{13}				VP
P38	Mask for digital auxiliary functions (Standard: **00000000**)	O7 = 2^6, O8 = 2^7, O9 = 2^8, O10 = 2^9, O11 = 2^{10}, O12 = 2^{11}, O13 = 2^{12}, O14 = 2^{13}				VP

4 Operation mode not possible with HEDA coupling, as the encoder zero pulse is not transmitted.

5 P36, after VP, is only accepted at the next curve zero point or with SETC, in order to avoid rapid jumps in the position set point. In curves with a slave value ≠ 0 in the curve zero point, this rapid change in position set point cannot be avoided.

No.	Meaning	Unit	Minimum value	Default value	Maximum value	Valid from
P39	Ramp time of internal time base	ms	0	**0**	4 000 000	VP
P68[6]	Filter for external speed feed forward 0: Filter switched off	%	0	**0**	550	VP
P79	Tracking warning (indicated by O15)	according to P90	0	**1**	<P13	VP
P90	Units for distance indication (supplemented)	"0": Increments (supplement) "**1**": mm "2": Inch "3": Degree (supplement); in "Universal drive" given in millidegree (1/1000 degree)				VC
P93	Operation mode	"1": Normal operation "2": Endless operation "**3**": Reset mode (supplement) "4": Speed control				imme-diately
P179	Ramp for P35	ms	0	0	4Mio	VP

The following parameters P80 to P88 only apply to the drive type "Roller Feed"

P80	Drive type		"2": Spindle drive "4/8": Rack and pinion/timing belt "16": Universal drive "32": Roller Feed (supplement)			VC
P82	Moment of inertia of the feed rollers	kgcm^2	0	0	70 000	VC
P83	Circumference of the slave feed rollers	mm	30	30	3000	VC
P84	Moment of inertia of gear box and clutch with reference to the drive axis.	kgcm^2	0,00	0	200,00	VC
P85	Gear ratio		1,0000000	1,0000000	100,0000000	VC
P88	Translatory moved mass	kg	0	0	500	VC
P210	Parallel mode	"**0**": linear processing of the program memory (previous settings) "1": the program is running during a positioning process and stops at the next positioning command With the bus, only the second positioning command is negatively cleared.				im-medi-ately

Define encoder interfaces (Option)						
P143	Encoder pulses per revolution (channel 1)		128	4096	2 000 000	VC
P144	Master input channel		="**4**": Encoder module E2 or E4			VC
P98	Distance of master axis per encoder revolution	according to M_T	0	**360**	4 000 000	VC

[6] **Attention:** Only use filter P68, if quantiziation noises can be heard due to low resolution in the master channel. Otherwise, set to 0 to reduce the tracking error to a minimum.

HEDA parameters (option A1 or A3)			
P18	Bit3[7]: fast start on HEDA Standard value: P18=0	Bit 0 =0 without PLC data interface =1 with PLC data interface Bit 1 =0 fast start on I15 not active =1 fast start on I15 active Bit 3 =0 no fast start on HEDA =1 fast start on HEDA active **P18 bit 1 and 3 only available with standard device CPX XX00**	VP (PLC data interface after Power on)
P184	Select parameter for HEDA-process value (Master) Standard value: P184=0	40: Encoder position 42: Internal time base 43: Normalized master position 44: Position set point in resolver increments 45: Position actual value in resolver increments 46: Differentiated resolver positions	VP
P188	Selection parameter for HEDA process value (Slave) Standard value: P188=0	40: Encoder coupling for encoder input signals (P184=40) 140: Encoder coupling for other input signals (P184≠40) 42: Internal time base 43: Normalized master position	VP
P243	HEDA operation mode	="0": with P250=0: independent single axis with P250=1 ...9: Slave to IPM via HEDA Bit 0="1": COMPAX as Master P250 must be set to 1. Bit 1="1": COMPAX as passive slave to COMPAX master P250 must be set to 1.	VP
P250	HEDA device address	**0** ... 9	VP

Default values are, unless otherwise stated, printed in bold.

[7] The bit-counting is beginning with 0.

24 Annex 1: Drift-free Operation by Scaled Curves

The scaling of the physical connections within COMPAX may result in figures which are not exactly representable and which are rounded. This fact causes a long-term drift of the position values, thus forcing you to make use of the label synchronization.

Checking of drift-free operation

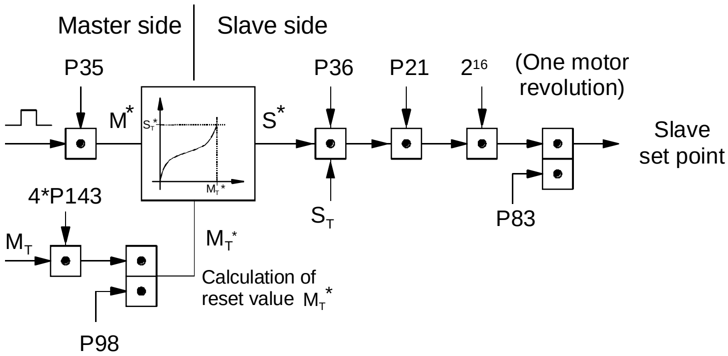
To obtain a long-term drift-free operation, certain parameters in COMPAX 70 must meet the following 3 conditions.
Required configuration:

- Universal drive (P80="16").
- Slave unit "Increments", "mm" or "Degree" (but not "Inch").

Scaling is influenced by the following values:

- P35: Scaling factor for master.
- P98: Distance of master axis per encoder revolution
- P143: Encoder pulse per revolution.
- M_T: Master cycle.
- S_T: Slave cycle.
- P36: Scaling factor for slave.
- P21: Factor for position calculation.
- P83: Travel of slave per motor revolution

Deriving from the master position these values are influencing the slave position according to the structure shown below.



The above values are physical values; only their total influence on the scaling of master- and slave-channel is of importance.

The curve must be assumed as non-linear and represents a separation of the physical areas of master and slave which can also be indicated by different units. For this reason the factors up to the curve as well as the factors after the curve can be treated separately.

In order to achieve a drift-free master position counting, an exact calculation of the scaled master cycle M_T* must be possible, i.e. the result must not have any digits after the comma.

1st condition

$$M_T^* = \frac{M_T \bullet 4 \bullet P143}{P98} = \text{ganzzahlig} \leq 4\,000\,000$$

whereby P35 must be "1".

A precise calculation for a drift-free slave cycle S_T* must be possible with open curves. Closed curves are always drift-free.

In open curves without extreme values (S formed), the difference between the last and first set point always corresponds to the slave cycle S_T.

Advice

In open curves with standstill zones at the beginning or end, it must be ensured that the first curve set point = 0 and the last = 0.9999999. Otherwise, long-term drift can occur.

2nd condition

$$S_T^* = \frac{S_T \bullet 2^{16}}{P83} = \text{whole number} \leq 4\,000\,000$$

at P93 = 0 (Increments)
or

$$S_T^* = \frac{S_T \bullet 2^{16}}{P83 \bullet 0{,}001} = \text{whole number} \leq 4\,000\,000$$

with P93 = 1 (mm) or 3 (degree).

In the rare cases where the curve is open and also has an extreme value, the calculation of R_S must use the difference between the last and first curve set point instead of S_T.

3. condition

- P83 = 2^a e. g. 1024 at "Increments" i. e.
- P83 = 1000 * S_T * 2^b at "mm" or "Degree"
- with a = whole positive number and b= whole number.

Complementary conditions for slave channel:

- P36 = S_T^* = whole number
- P21 = 1

Remark!

It is necessary that both channels, master and slave channels, are drift-free.

Exception!
When using label synchronization, 1 drift-free channel is adequate.

Implementation of any scaling factor

With regard to these connections, with COMPAX XX70 there can be realized any gear factor (represented as counter/denominator).

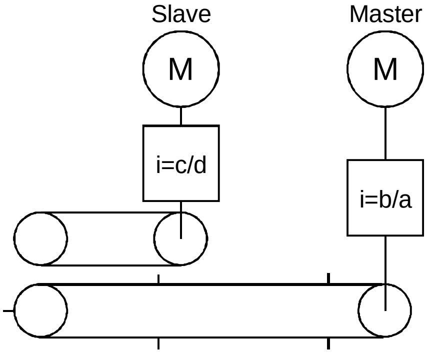
Provided that
- P35 = P36 = P21 = 1
- P80 = 16 (universal drive)
- P90 = 0 (Increments)
- P83 = P93 = 2^n e. g. 1024
- P143 = 0 ... 1Mio

the gear factor between slave and master is:

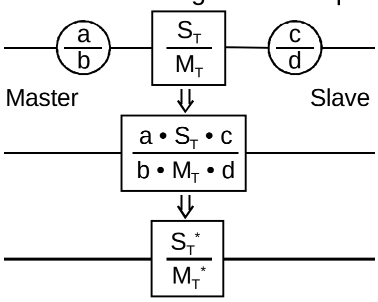
$$i = \frac{S_T}{M_T}$$

As a curve there will be put in a straight line with the points 0,0 and M_T, S_T.

Example: A slave system must be drift-free and synchronous with the master.



This results in the following relationships:



The master contains a 3-stage gear box with tooth ratios of:

$$i_M = \frac{20}{63} \bullet \frac{26}{64} \bullet \frac{6}{53} = 0{,}014600179..$$

The slave also contains a 3-stage gear box with tooth ratios of:

$$i_S = \frac{20}{82} \bullet \frac{8}{33} \bullet \frac{11}{62} = 0{,}010490427..$$

With these transmission relationships, it is impossible to obtain drift-free operation using scaling factors.
COMPAX 70 provides a drift-free operation with the master and slave cycles.
In order to achieve this, the overall relationship must be calculated and reduced as much as possible.

$$\left(\frac{20}{63} \bullet \frac{26}{64} \bullet \frac{6}{53}\right) \bullet \left(\frac{82}{20} \bullet \frac{33}{8} \bullet \frac{62}{11}\right) = \frac{S_T^*}{M_T^*} = \frac{16\,523}{11\,872}$$

Enter a straight line using the CamEditor:
Set points:

	Master	**Slave**
Curve set point 1:	0	0
Curve set point 2:	11 872	16 523

Where:
P35=P36=1; P83=P98=1024; P90=0 (Increments)
P143 is set to the pulse number of the encoder (on the master motor) or the encoder simulation.

25 Annex 2: Interface Description concerning Cam Memory

General Determinations for Curves

A curve is composed of controlling block and set points.

The controlling block contains:

- the reference value for the master (master cycle)
- the reference value for the slave (slave cycle)
- the numbers of the corresponding set points (from ... to)
- the parameters for the coupling motions in scaled version (with reference to M_T^*)
- the parameters for the online label synchronization in scaled version (with reference to the master- and slave-cycle)

The set points contain

- set points for position in scaled version (with reference to the master-cycle) and
- auxiliary functions

Organization of the Cam Memory

The cam memory in the zero-power-ram includes a total of 5460 addresses of 24 bit each. The 5 addresses below are reserved for status informations. The set points are memorized from number 6 at the even-numbered addresses. Starting with number 7 the odd-numbered addresses are occupied by the auxiliary functions. The controlling blocks are to be found downward, starting with address 5460. There are reserved 20 addresses per controlling block.
The addresses are accessible decimally by a preceding format information. The argument must be of the corresponding format.

Number Formats

The max. representable fractional number is 0.9999999. If there is an open curve without turning point this value has to be used as the last set point in order to avoid a long-term drift. This value then corresponds to the slave-cycle, which is due to the fact that the difference between the last and the first set point is used for the reset function. This difference must exactly correspond with the slave-cycle. It goes without saying that the first set point has to be "0".

Access using RS232 or RS485 via ASCII

Transfer of Data

The transfer of the curve parameter and set points is carried out in the ASCII format. Some examples are listed below:

Position of 1st set point:	"F6=0<cr>"
Auxiliary function of 1st set point:	"B7=001;2;003<cr>"
....	
Position of 10th set point:	"F24=.9<cr>"
Auxiliary function of 10th set point:	"B25=001;002;003<cr>"
Master-cycle of curve 0 (360 degree):	"I5460=360<cr>"
Slave-cycle of 1st curve:	"I5436=360<cr>"

After each string COMPAX 70 sends back the sequence <cr>, <lf> and prompt (> = $3E). Before sending the next string, "prompt" must be ordered. During the data transfer there must not be any error at COMPAX 70 and no error is allowed to emerge (this can be checked by S30 "last error)!

Checking of Data

The data can be checked by ordering the corresponding addresses with identical control marks.

Example:

After receiving the sequence "F6<cr>" COMPAX 70 returns the sequence
"F0006=0.1234567<cr><lf><$3E>".
In the following there are exemplarily defined 2 curves (straight lines) with 11 set points each.

COMPAX 70 - Command

The command "RESETF" is used to reset the whole cam memory to "0".
This function takes up to 1s.

Enabling a new Curve

After having changed the cam memory it must be declared as valid by VF.
This function takes up to 0.5s.

Accelerating the VF command

To speed up the VF command, COMPAX saves a table of modified addresses when there are modifications in the cam memory. Maximum table contents: 20 entries. As soon as a VF command with a table entry is noted, only the modified values are transferred to the DSP. When the table is full, the entire cam memory is transmitted. This enables a VF acceleration, regardless of whether set points, auxiliary functions or curve headers have been altered.
The VF command is also permitted in cam operation, i.e. in active LOOP commands.

Advice

If, at the time of the VF command, there is no modification in the cam memory, the entire VF (ca. 0.5s) is executed.

Attention!

With longer transmission times, it is possible that the synchronicity between master and slave is lost.

Access using a bus system

Number formats / Format conversion 1. 24 Bit-Integer: Ix

This format is used for entries in the controlling block.
Format conversion
Example: Ix = 1024
Conversion into hexadecimal number
Ix = 0 x 400
Examples:

	Contents of the memory cells		
number	MSB		LSB
1024	00	04	00
512	00	02	00
0	00	00	00

2. 3 x 8 Bit Integer: Bx

This format is mainly used for auxiliary functions.

Format conversion

Example: Bx = 128; 0; 0
Each number is an 8 Bit complement to two and must be converted separately into a hexadecimal number.
Bx = 0 x 80; 0; 0
Examples:

	Contents of the memory cells		
Numbers	MSB		LSB
Bx=128;0;0	00	00	80
Bx=255;127;255	FF	7F	FF
Bx=1;1;128	80	01	01
	analogue channel 1	analogue channel 0	digital out-puts

3. 24 Bit fractional: Fx

This format is used for the set points.

VZ 2^{-1} 2^{-2} ....2^{-23}

3 Byte after the comma VZ: value sign

Negative numbers are shown in complement to two.

Format conversion of the fractional format in bus access:

Example: Fx= 0,9999999
1. 0,9999999 x 2^{23} = 8388607
2. Conversion into hexadecimal number = 0 x 7FFFFF

Examples:

	Contents of the memory cells		
number	MSB		LSB
0,9999999	7F	FF	FF
0,5	40	00	00
0	00	00	00
-1	80	00	00
-0,5	C0	00	00
-0,0000001	FF	FF	FF

When reading the format via the bus, hexadecimal values are displayed.
The fractional format is obtained by:
1. Conversion into an integer value.
2. $Fx = \frac{Ix}{2^{23}}$.

Examples:

B7=128;0;0

Auxiliary function of the first set point:
O14 = 1, O13 ... O7 = 0,
analogue channels 0 and 1 = 0V

B9=255;127;255

Auxiliary function of the second set point: O14 ... O7 = 1
Analogue channel 0 = 10V (with P73=100)
Analogue channel 1 = -0.078V "

B11=1;1;128

Auxiliary function of the third set point: O14 ... O8=0, O7=1
Analogue channel 0 = 0.078V "
Analogue channel 1 = -10V "

In general:

"Bxxxx=(O14...O7)[8];(analogue channel 0);(analogue channel 1)<cr>"

[8] Valence: O7=Bit 0,...,O14=Bit 7.

General data:

No.	Format&Address	Significance	Value (ex.)	Ref. to
1	I0001	Number of curves in the cam memory	5	

Storage of Curve Number 1
Controlling block:

No.	Format&Address	Significance	Value (ex.)	Ref. to
1	I5460	Master cycle integer	360	
2	F5459	Master cycle fractional	.0	
3	I5458	Number of 1st set point	1	
4	I5457	Number of last set point	11	
5	I5456	Slave cycle integer	360	
6	F5455	Slave cycle fractional	.0	
7	F5454	Coupling position	.1	M
8	F5453	Synchronous position	.6	M
9	F5452	Decoupling position	.2	M
10	F5451	Brake position	.7	M
11	F5450	Standstill position	-.1	S
12	F5449	---	0	
13	F5448	Label set position	.5	M/S
14	F5447	Label window	.05	M/S
15	F5446	Correction starting	.1	M
16	F5445	Correction end	.9	M
17	F5444			
18	F5443			
19	F5442			
20	F5441			

There is reserved a total of 20 adresses per curve for each controlling block.

Set points:

No.	Format&Address	Significance	Value (ex.)
1	F0006	1st set point	0
1	B0007	1st auxiliary function	1;10;246
2	F0008	2nd set point	.1
2	B0009	2nd auxiliary function	3;20;236
3	F0010	3rd set point	.2
3	B0011	3rd auxiliary function	7;30;226
4	F0012	4th set point	.3
4	B0013	4th auxiliary function	15;40;216
5	F0014	5th set point	.4
5	B0015	5th auxiliary function	31;50;206
6	F0016	6th set point	.5
6	B0017	6th auxiliary function	63;60;196
7	F0018	7th set point	.6
7	B0019	7th auxiliary function	127;70;186
8	F0020	8th set point	.7
8	B0021	8th auxiliary function	255;80;176
9	F0022	9th set point	.8
9	B0023	9th auxiliary function	254;90;166
10	F0024	10th set point	.9
10	B0025	10th auxiliary function	252;100;156
11	F0026	11th set point	.9999999
11	B0027	11th auxiliary function	248;110;146

Storage of curve number 2

Controlling block:

No.	Format&Address	Significance	Value (ex.)	Ref. to
1	I5440	Master cycle integer	360	
2	F5439	Master cycle fractional	.0	
3	I5438	Number of 1st set point	12	
4	I5437	Number of last set point	22	
5	I5436	Slave cycle integer	360	
6	F5435	Slave cycle fractional	.0	
7	F5434	Coupling position	.1	M
8	F5433	Synchronous position	.6	M
9	F5432	Decoupling position	.2	M
10	F5431	Brake position	.7	M
11	F5430	Standstill position	-.1	S
12	F5429	---	0	
13	F5428	Label set position	.5	M/S
14	F5427	Label window	.05	M/S
15	F5426	Correction starting	.1	M
16	F5425	Correction end	.9	M
17	F5424			
18	F5423			
19	F5422			
20	F5421			

There is reserved a total of 20 adresses per curve for each controlling block.

Set points:

No.	Format&Address	Significance	Value (ex.)
12	F0028	1st set point	0
12	B0029	1st auxiliary function	1;10;246
13	F0030	2nd set point	.1
13	B0031	2nd auxiliary function	3;20;236
14	F0032	3rd set point	.2
14	B0033	3rd auxiliary function	7;30;226
15	F0034	4th set point	.3
15	B0035	4th auxiliary function	15;40;216
16	F0036	5th set point	.4
16	B0037	5th auxiliary function	31;50;206
17	F0038	6th set point	.5
17	B0039	6th auxiliary function	63;60;196
18	F0040	7th set point	.6
18	B0041	7th auxiliary function	127;70;186
19	F0042	8th set point	.7
19	B0043	8th auxiliary function	255;80;176
20	F0044	9th set point	.8
20	B0045	9th auxiliary function	254;90;166
21	F0046	10th set point	.9
21	B0047	10th auxiliary function	252;100;156
22	F0048	11th set point	.9999999
22	B0049	11th auxiliary function	248;110;146

Under address 1 of the cam memory there must be indicated the number of curves memorized in COMPAX

26 Index